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INDIANA UNIVERSITY

Scores on the Interpretation of Data Test: Their Relationship to Measures of Achievement, Personality, and Interest

by
Nicholas A. Fattu
and
William H. Fox

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N.A.F.
W.H.F.

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SCORES ON THE INTERPRETATION OF DATA TEST: THEIR RELATIONSHIP TO MEASURES OF ACHIEVEMENT, PERSONALITY, AND INTEREST

INTRODUCTION

THE ability to draw inferences that are consistent with one's information is probably substantially correlated with capacity to function efficiently and effectively as a citizen in a democracy. Ability to see relationships, to make comparisons, to suspend judgment until pertinent facts are collected, and to sift relevant from irrelevant information are perhaps significant aspects of ability to draw inferences. Cultivation of this higher mental process will be facilitated and better effected as knowledge of these various abilities is investigated in relation to other aspects of the individual's development. The present study is only one of the many investigations which it is hoped will be made into this ability to draw inferences.

The Purposes of the Study

The primary purpose of this study is embodied in the title. That is, the study aims to investigate existing relationships between various interpretative abilities, as measured by an objective standardized test, and other measurable attributes. However, it would be a sterile educational research, indeed, if it were not motivated by some higher purpose than mere mathematical calculations.

The present investigators had several secondary purposes in mind, such as: will such a study throw light on the problem of variation of such interpretative abilities between either sex groups or school groups? Will the data give some information concerning general development of these abilities, either explicit or, what is more likely, implicit? Is it possible in such a study to uncover data which will be useful to those whose responsibilty it is to help the students in their efforts to find the most efficient use of their time; in other words, will it be useful in the guidance program? The final conclusions from this study should embody some attempt, either from a positive or from a negative viewpoint, to satisfy these purposes.

The specific questions to be investigated are:

1. What is the nature of the criterion, the ability to interpret information?
   (a) What are some of the important abilities?
   (b) What are the interrelationships among these abilities?
   (c) What is the reliability of measurement of these abilities?
   (d) What differentiation exists between sexes and schools, and is there any evidence of a differential effect or interaction between sexes and schools?
2. What relationships exist between measures of ability to interpret data and other measured abilities or attributes of students? Are

there any sex, school, or interaction differentiations between interpretation of data abilities and any of the following?

(a) Chronological age.
(b) General ability, of either a language or a non-language type.
(c) Reading comprehension, with its components of vocabulary, speed of reading, and level of comprehension.
(d) Mathematics ability, with its components of skills; facts, terms, and concepts; applications; and appreciation.
(e) Social studies ability, and its components of facts, skills, and applications; terms and concepts; and comprehension interpretation.
(f) Science ability, and its components of facts, skills, and applications; terms and concepts; and comprehension and interpretation.
(g) Health knowledge.
(h) Quality of school work, as measured by credit-point ratio.
(i) Interests, involving such components as mechanical, computational, scientific, persuasive, artistic, literary, musical, social service, and clerical interests.
(j) Social competency, with such components as competency to solve problems related to health, to personal economics, to family and community relationships, and to social-civic situations.
(k) Personality adjustment, with its components of home adjustment, health adjustment, social adjustment, and emotional adjustment.
(l) Socio-economic status, with its components of cultural, economic, and aesthetic status.

Description of the Measuring Instruments

The measuring instruments used were as follows:

(a) *Chronological age.* Ages were taken directly from school records.

(b) *General ability.* General ability of both the non-language and the language type was measured by the California Short-Form Test of Mental Maturity, Intermediate Form (machine-scoring edition)[1] published by the California Test Bureau. This test is made up of six subtests purporting to measure the maturity of apperceptive processes, spatial relationships, and the mathematical and logical aspects of reasoning. Three of the subtests are verbal and three are non-verbal to the extent that the content does not utilize language symbols. Reliability coefficients are about .93 for the language part and .77 for the non-language part. A total score is provided, but was not considered in this study. Besides raw scores, the test provides mental ages and I.Q.'s. Mental ages were used in this study.

[1] Buros, Oscar K., ed., *The Third Mental Measurements Yearbook*, Rutgers University Press, New Brunswick, N.J., 1949, pp. 304-305.

(c) *Reading comprehension.* Reading comprehension was measured by the Cooperative English Test C1, Lower Level, Form S,[2] published by the Cooperative Test Service. The test breaks down into part scores on vocabulary, speed of reading, and level of comprehension. A total score is obtained by summation of the parts, but was not considered in this study. Reliabilities range from .75 to about .90 on the various parts of the test. Each raw score is convertible to a scaled score. Scaled scores were used in the present study. A unique and useful feature of the scoring makes it possible to get a level score without the influence of speed. Rather high correlations (.70 to .80) have been reported between aspects of this test and group intelligence tests.

(d) *Mathematics.* Mathematical ability was measured by the Cooperative Mathematics Test for Grades 7, 8, and 9, Form Q,[3] published by the Cooperative Test Service. Besides a total score, this test is divided into the following sub-aspects: (1) skills, (2) facts, terms, and concepts, (3) applications, and (4) appreciation. The total score was not considered in the present study. Scaled scores provided for each part were used. Not too much information is available on the reliability of each of the subtests, but sufficient evidence has been found to suggest that the part score reliabilities are all above .70, while the total score reliability is about .92. This test is especially good in view of the fact that the subtests are specifically related to important expected outcomes of an adequate teaching situation. Subtest intercorrelations reported tend to range from about .46 to .72.

(e) *Social studies.* Social studies ability was measured by the Cooperative Social Studies Test for Grades 7, 8, and 9, Form R,[4] published by the Cooperative Test Service. Although a total score is possible, it was not made a part of the present study. The three subtest scores considered were: (1) facts, skills, and applications, (2) terms and concepts, and (3) comprehension and interpretation. Scaled scores are available for each subtest and were used in the present study. Reliability and validity coefficients are not listed in the manual. Reliability coefficients are probably high, since the test contains an extensive number of items. As in the case of the mathematics test described above, the delineation of items into separate parts closely related to worth-while educational objectives is a useful feature.

(f) *Science.* Science ability was measured by the Cooperative Science Test for Grades 7, 8, and 9, Form R,[5] published by the Cooperative Test Service. Besides a total score, this test provides subscores identical to those listed above for the social studies test. Raw scores for the subtests and total are directly convertible to scaled scores. This study used the subtest scaled scores, but excluded consideration of the total score. Available data on reliability and validity are scarce.

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[2] *Ibid.*, pp. 524-526.
[3] *Ibid.*, pp. 401-402.
[4] *Ibid.*, pp. 606-608.
[5] *Ibid.*, pp. 594-596.

(g) *Health Knowledge.* Health knowledge was measured by the Gates-Strang Health Knowledge Test, Form D,[6] published by the Bureau of Publications, Teachers College, Columbia University. This test gives only one score, a raw score. Some provision for comparisons is made through quoted statistics obtained in both large city systems and suburban high schools. The manual includes the obtained range, median, and quartile points 1 and 3 under the conditions listed above. Reliability of Form D was quoted as .82.

(h) *Quality of school work.* Quality of school work was measured by assigning weights to each letter grade made in various subjects taken by the student in the two previous semesters. Only academic subjects were considered, which eliminated music, art, and physical education. In weighting the grades, the following values were assigned: A = 4, B = 3, C = 2, D = 1, and F = 0. The sum of these weights was divided by the sum of credits to obtain a credit-point ratio.

(i) *Interests.* Vocational interest patterns were measured by the Kuder Preference Record, Form Bm,[7] published by Science Research Associates. This instrument yields scores in nine broad categories, namely: mechanical, computational, scientific, persuasive, artistic, literary, musical, social service, and clerical. Reliabilities are quoted for the sexes separately. For men these range from .94 on the mechanical part (the highest) to .85 on the clerical part (the lowest). For women they range from .90 on the literary, social service, and clerical parts to .86 on the persuasive part.

(j) *Social competency.* The ability to solve problems arising in social situations was measured by Tests of the Socially Competent Person, published by the Bureau of Publications, Teachers College, Columbia University. This test covers four aspects, namely: (1) ability to solve health problems, (2) ability to solve problems connected with personal economics, (3) ability to solve problems involving family and community relationships, and (4) ability to solve social-civic problems. This is one of the older tests in the field (copyright, 1937) and would probably be more effective in a revised edition. However, it is one of the few tests which aims at measuring these outcomes of the educational program. Reliability of the total test ranges from .83 to .94 for various grade levels.

(k) *Personal adjustment.* Personal adjustment was measured by the Bell Adjustment Inventory, Student Form, published by the Stanford University Press. It yields four adjustment scores: (1) home adjustment, (2) health adjustment, (3) social adjustment, and (4) emotional adjustment. Reliability coefficients range from .80 on the health adjustment scale to .93 on the total score.

(l) *Socio-economic status.* Socio-economic status was measured by the American Home Scale, published by Science Research Associates. Three aspects of this subject were included in the present study, namely: cultural, economic, and aesthetic. Percentile scores are available for the raw scores on each subtest and for the total; however, raw scores

[6] *Ibid.*, p. 476.
[7] *Ibid.*, pp. 658-663.

were used in this study. Reliabilities quoted are not very high; they range just a little below .70 on each of the parts. Reviewers of this test vary in their opinions of its value, ranging from those who are enthusiastic to those who are sharply critical.

The Sample

The cases for this study included all ninth graders in two Indiana high schools. The first of these high schools is located in a city of approximately 11,000 people located north of the middle of the state, and near the center of the state from east to west. The second of these schools is a consolidated rural high school, located very near the largest metropolitan area of the state.

No attempt was made to select these two schools on the basis of representativeness. Rather, the choice was made because it was possible in both places to collect a vast amount of data, since school surveys were being carried out at the time. The city school is probably more representative of its type than the rural school. The rural school, situated as it is near the state's largest city, probably is not so representative of rural high schools, as it is somewhat larger than the typical rural high school of the state and the population from which it draws is suburban rather than rural.

There is nothing in the survey reports to indicate that school practices in either community are unusual either from an ultra-progressive or an ultra-conservative point of view. Both schools have some excellent teaching situations as well as some which are average or mediocre. Both schools give about average support to the educational program. The facilities and equipment in both schools are average or a little better than average. Both offer a near-traditional, more or less subject-centered curriculum, with some allowance for individual student needs.

From an environmental viewpoint, the two school situations might well be considered equated, since there are practically no topographical barriers in restraint of experimental opportunities. Observation would lead to the conclusion that the students in both schools are typical midwestern native stock, who have had average or perhaps a little above average educational opportunities.

All of the ninth graders in both schools were included in the study. There were fewer girls than boys in the city school, and about an even sex division in the township school. On a purely observational basis these youngsters would appear to be somewhat representative of a large proportion of Indiana high school freshmen. The reader may draw his own conclusions as to whether this hypothesis is tenable, especially after he examines the data which are presented later. A more defensible hypothesis might be that these students are representative of the classes passing through this grade level in these particular schools from year to year.

Interpretation of Data Test

Background. The Interpretation of Data Test, which forms the criterion of the present study, grew out of the systematic efforts made by Tyler and his associates[8] to appraise certain aspects of critical thinking. They began by trying to clarify objectives and analyze student behavior in achieving those objectives. Important facets of critical thinking were enumerated under the following rubrics:

1. Ability to interpret data
2. Ability to apply principles of science
3. Certain abilities associated with an understanding of the nature of proof
4. Ability to formulate hypotheses

The latter was only implicitly included.

Development of the Test. The analysis of interpretation of data ability led the committee to consider, first, what students do when they interpret data, and second, what kinds of data they should be able to interpret. From a wide range of behaviors, including ability to judge accuracy and relevance of data, to see relationships, to recognize limitations, and to formulate hypotheses, the committee selected two, the ability to see relationships and the ability to recognize limitations of data, as most significant. In their judgment the first involved the ability to make comparisons and to recognize trends, and the second involved the recognition of what additional information was needed, and the tendency to refrain from making judgments until necessary facts were at hand. This did not preclude the making of qualified inferences when the situation warranted.

It was recognized that ability to make original interpretations and ability to judge critically interpretations of others might not be closely related, but, since the data most individuals encounter in life are already interpreted to some extent, emphasis was put on critical judgment of these interpretations.

Ability to evaluate the dependability of data and ability to formulate hypotheses were recognized as important. In evaluating dependability of data, a person might question the competence, bias, or integrity of the person who presents the data; he might attempt to determine the adequacy and appropriateness of the methods, techniques, and controls used in obtaining the data, and the adequacy and appropriateness of methods of summarizing the data. In formulating hypotheses from the data, he might infer probable causes or predict probable effects.

Ability to perceive relationships and to recognize limitations of data were particularly emphasized in developing the test. Data selected were presumably new to the student. A variety of forms was used and various subject fields, problem areas, and relationships were sampled.

Free-response essay-form test results and current reading materials were examined to note the kinds of relationships involved in

[8] Smith, Eugene R.; Tyler, Ralph W.; and the Evaluation Staff, *Appraising and Recording Student Progress*, Adventures in American Education, Vol. III, Harper and Brothers, New York, 1942.

interpretations, kinds of assumptions made, and accuracy and adequacy of inferences. These analyses were classified in terms of the kinds of relationships involved. and in terms of the differences in degree of accuracy with which they were used by the students. From this information the short-answer type of exercise was constructed.

The 2.51 Test. The 2.51 Test used in the present investigation was intended for high school level. It contains ten sets of data, selected according to the committee's criteria. Data are presented in a variety of forms. They are taken from several fields and contain information pertinent to a variety of topics.

Each set of data is followed by 15 statements which purport to be interpretations. The student is asked to judge each statement by placing it in one of five categories with reference to the data: true, probably true, doubtful, probably false, and false.

In refining the test, student responses were analyzed and, where they conflicted seriously with the key, the item was carefully examined and revised.

Scoring. Scores are determined by tabulating a student's response for each item in relation to a jury's key for the item. Student responses can be summarized in terms of general accuracy, beyond data, caution, and crude errors. General accuracy means the extent to which judgment of the student agrees with that of the jury. These judgments may be subdivided further into (a) probably true and probably false, (b) insufficient data, (c) true-false statements.

The "going beyond data" score indicates the extent to which the student marks items keyed probably true as *true*, insufficient data as *probably true* or *probably false*, and probably false as *false;* that is, the extent to which the student gives the interpretation greater certainty than warranted by the data.

The caution score indicates the extent to which the student marks statements keyed true as *probably true*, probably true as *insufficient data*, false as *probably false*, and probably false as *insufficient data;* that is, the extent to which the student gives less certainty to the statements than does the jury.

The crude errors score indicates the extent to which the student marks true or probably true statements as *false* or *probably false*, and vice versa. This type of error may be due to carelessness in reading data or interpretations or to misunderstanding.

Interpretation. Student responses may be analyzed in terms of two pertinent questions:

1. To what extent does the student recognize limitations of the data? General accuracy, caution, and beyond data scores are used.
2. How accurately does the student see various types of relationships in the data? Probably true or probably false, insufficient data, true-false, and crude error scores are considered.

The committee indicated that "it is usually inadvisable to interpret scores on this test in terms of national norms, since opportunities to develop these abilities vary markedly from group to group." They,

however, present the following results which were found for ninth graders.

Form 2.51

	Mean	*S.D.*
General Accuracy	40.1	10.4
Caution	27.8	11.0
Beyond Data	51.4	12.4
Crude Errors	16.9	6.0

Validity. Validity was studied in terms of judgments of the committee and analysis of types of data commonly found in curricular and other reading materials. The interpretations are said to be representative of the types that students were found to use when they made their own interpretations of data. Studies of score distributions made by pupils showed that no pupil from the ninth grade to the junior college level received the maximum possible score. The distribution was symmetrical, with concentration of scores at the mean, and the means tended to increase with grade level.

Reliability. Odd-even reliability was given as follows:

N=284	
General Accuracy	0.92
Beyond Data	0.91
Caution	0.91
Crude Error	0.82
True-False	0.86
Insufficient Data	0.92
Probably True or Probably False	0.87

Methods and Techniques

Collection of Data. Standardized tests were administered at two different periods to the pupils involved in this study. Some of the tests were taken by the pupils when they were in the second semester of the eighth grade. These included tests of mental maturity, reading comprehension, mathematics, social studies, science, health knowledge, and social competency. This testing took place during April for those in the city schools and during May for those in the township schools. In no instance was there more than one month difference in the time of administration.

The test used as a criterion in the study and tests of personality, vocational preferences, and environment were administered in March of the succeeding year, when the students were ninth graders. These four tests were administered to the two schools on approximately the same dates; in no case were there more than six days between the administration of the first and last tests. In view of the conditions stated above, it is the opinion of the present investigators that any observable differences between schools cannot be accounted for on the basis of differences in testing dates, since the period of time between administrative dates was in no case very large. All of the tests were administered under the supervision of staff members of the Division of Research and Field Services at Indiana University.

Tabulation Procedures. The students responded to the test items on special machine-scoring answer sheets. These were scored and

checked in the Division of Research and Field Services at Indiana University. Master sheets were tabulated, using raw scores, equated scores, and other types of scores according to the scoring instructions stipulated for the various tests. The test scores on mental maturity were converted to mental ages. Equated scores were used in the case of mathematics, social studies, and science. Raw scores were used for all of the other tests with the exception of the Interpretation of Data Test; the results on this, the criterion test, were tabulated in terms of percentage of scores.

Test scores were coded by determining the range of each separate distribution of scores. Each of these ranges was then categorized, using in every distribution ten class intervals, ranging from zero to nine.

The coded scores were then punched on I.B.M. 80-column cards, together with coded chronological ages and credit-point ratios. Sex and school were also indicated on each card. In setting up all except the first table in this study, the coded scores were converted back to their original bases.

Processing of the data was done with an I.B.M. counter-sorter and printer-tabulator. By means of the tabulator the summation of scores, summation of squared scores, and summation of cross products were obtained for each combination of variables included in the study.

Notation. Throughout this study the following statistical notation has been employed:

Statistic	*Symbol*
Mean	$\overline{X}$
Variance	s^2
Standard Error of the Mean	$s_{\overline{x}}$
Correlation Coefficient	r
Reliability Coefficient	r_{11}
Number of Cases	N

Reliability of various parts of the Interpretation of Data Test was determined by odd-even correlation. In the construction of the Interpretation of Data Test the items are randomized for serial order. Two scoring keys were cut for each part of this test, one for the odd items and the other for the even items. After the interpretation of data papers were scored for total, they were rescored using the two keys to obtain the odd and even scores on each test part. The odd-even correlations were adjusted by means of the Spearman-Brown prophecy formula.

Delimiting the Study

It was apparent at the outset that some limitation would have to be placed upon the study in order to reduce it to a size suitable for bulletin publication. The interpretation of data test provides seven different scores, namely, general accuracy, accuracy in probably true and probably false, accuracy in insufficient data, accuracy in true-false, a caution score, a beyond data score, and a crude error score. The second, third, and fourth of the above scores contribute to the

score on general accuracy. There is no doubt that these three subtest scores might present interesting results for comparative analysis. However, since there was a need for delimiting, and since these three part scores were incorporated in general accuracy, they were arbitrarily eliminated from consideration at this time. This left the following scores: general accuracy, caution, beyond data, and crude errors.

Table I shows the computed raw score statistics, including reliability coefficients for sex and school groups, on these four test scores. The reliability coefficients for general accuracy ranged from .85 to .90 for the various sex and school groups, and caution reliability coefficients had the same range. Beyond data coefficients ranged from .88 to .92, and crude error reliabilities, from .78 to .89. Thus reasonably satisfactory reliability coefficients existed for all of the sex and school groups on these four scores. The reliability coefficients for beyond data scores appeared to be a little higher, and those for crude errors appeared to be a little lower than those for the other test scores.

TABLE I. COMPUTED RAW SCORE STATISTICS, INCLUDING RELIABILITY COEFFICIENTS FOR SEX AND SCHOOL GROUPS ON FOUR TESTED ASPECTS OF ABILITY TO INTERPRET DATA

Groups	N	General Accuracy				Caution				Beyond Data				Crude Errors			
		$\bar{X}$	s_x	s^2	r_{tt}	$\bar{X}$	s_x	s^2	r_{tt}	$\bar{X}$	s_x	s^2	r_{tt}	$\bar{X}$	s_x	s^2	r_{tt}
BOYS																	
School 1	77	45	1.7	227	.86	23	1.2	121	.86	58	1.6	249	.89	24	.9	71	.78
School 2	80	50	2.0	312	.88	21	1.3	126	.90	59	1.9	294	.90	20	1.1	90	.89
All boys	157	47	1.3	279	.88	22	.9	124	.88	59	1.3	266	.92	22	.7	84	.85
GIRLS																	
School 1	74	49	1.9	246	.89	22	1.1	78	.90	59	1.5	160	.88	21	.9	62	.81
School 2	80	56	1.9	284	.85	24	1.0	84	.85	53	1.7	238	.89	17	.9	54	.78
All girls	154	53	1.3	266	.89	23	.7	82	.88	56	1.2	210	.89	19	.6	63	.80
TOTAL																	
School 1	151	47	1.3	243	.89	22	.8	101	.87	58	1.2	207	.88	23	.7	69	.79
School 2	160	53	1.4	297	.90	23	.8	104	.89	56	1.3	269	.93	19	.7	76	.85
Total	311	50	0.9	281	.89	22	.6	104	.88	57	.9	241	.91	21	.5	77	.83

Inspection of the group means reveals some interesting points. The widest differences in means between sexes and schools occurred on the general accuracy test, followed in order by the crude error test, the caution test, and the beyond data test. In the beyond data test only mean differences for girls appeared to be of any noticeable magnitude.

Some group differences in variances appeared for each tested aspect. Variances for boys were in general higher than those for girls. Variances between schools were somewhat larger in the case of general accuracy and beyond data than in the case of the other two tested aspects. Considered as a whole, the variances in crude error scores for the different groups were seemingly less pronounced than those for any other tested aspect. However, inspection of the variances by application of the t-test reveals no significant differences.

It appeared advisable to study each tested aspect in regard to both sex and school differences in means and variances. However, there was need for further limitation of the study. Therefore, in light of the statistics in Table I, some arbitrary decisions were made as follows:

TABLE II. INTERCORRELATIONS FOR SEX AND SCHOOL GROUPS ON THREE TESTED ASPECTS OF ABILITY TO INTERPRET DATA

	N	Intercorrelations		$\bar{X}$	s^2
		Caution	Beyond Data		
GENERAL ACCURACY					
School 1, boys	77	.22	-.73	31	122
School 2, boys	80	.39	-.78	33	155
All boys	157	.30	-.75	32	140
School 1, girls	74	-.12	-.64	32	114
School 2, girls	80	.32	-.83	38	119
All girls	154	.13	-.76	35	135
School 1, total	151	.07	-.69	32	119
School 2, total	160	.37	-.81	35	142
Total	311	.23	-.76	34	135
CAUTION					
School 1, boys	77		-.74	25	158
School 2, boys	80		-.76	23	176
All boys	157		-.75	24	168
School 1, girls	74		-.42	25	98
School 2, girls	80		-.68	26	120
All girls	154		-.57	25	110
School 1, total	151		-.62	25	129
School 2, total	160		-.73	25	150
Total	311		-.68	25	140
BEYOND DATA					
School 1, boys	77			49	186
School 2, boys	80			49	193
All boys	157			49	190
School 1, girls	74			49	121
School 2, girls	80			45	168
All girls	154			47	150
School 1, total	151			49	154
School 2, total	160			47	185
Total	311			48	171

1. School and sex groups were kept intact in studying relationships of other tested aspects with the aspect of general accuracy in ability to interpret data.

2. Only the total group was considered in studying relationships of other tested aspects with the aspects of caution and beyond data.

3. A study of the relationships of other tested aspects with crude errors in interpreting data was postponed for later consideration.

Table II shows the intercorrelations for sex and school groups on the three tested aspects of ability to interpret data. The means and variances here are quoted in terms of percentage scores, and are not directly comparable to the means and variances appearing in Table I. The intercorrelations suggest that there is some difference in what is tested by the three aspects of general accuracy, caution, and beyond data. In comparing general accuracy with caution, the highest intercorrelation obtained was .39 and the lowest was .07, with one negative coefficient. In general it appears that the correlation of these two aspects was positive but low. There was little consistency between scores made on the caution test and scores made on general accuracy.

The intercorrelations between general accuracy and beyond data had a range from –.64 to –.83. This would seem to indicate a high

degree of reciprocity between these two tested aspects. In other words, the evidence suggests that a high score in general accuracy tended to be accompanied by a low score in beyond data, and vice versa.

The intercorrelations between caution and beyond data ranged from –.42 to –.76, with most falling at –.68 or higher. This suggests that there was a moderate degree of correspondence between these two tested aspects. In general, those who made a high caution score had a tendency to make a low beyond data score, and vice versa.

Comparisons among the intercorrelations found within the various subdivisions are made in Table III. In this table the correlations are transformed into inverse hyperbolic tangents, which are approximately normally distributed, and the chi-square test[9] of significance is applied. Among the intercorrelations of general accuracy and caution scores, only two were significantly different at the one per cent level, that between girls in school 1 compared with girls in school 2 and that between all pupils in school 1 and all pupils in school 2. The difference between intercorrelations of the two schools was probably due to the difference between the girls of the two schools. Boys and girls in school 1 and in school 2 exhibited essentially the same structuring of performance in what is contained in the correlations between general accuracy and caution scores.

TABLE III. CHI-SQUARE TEST FOR SIGNIFICANCE OF DIFFERENCES BETWEEN PAIRS OF INDEPENDENT CORRELATIONS FROM SIMILAR SAMPLES[a]

	Chi Square for General Accuracy and Caution	Chi Square for Beyond Data and General Accuracy	Chi Square for Caution and Beyond Data
Between boys and girls in school 1	0.4	1.1	9.2**
Between boys and girls in school 2	0.2	0.8	1.1
Between school 1 and school 2 (boys)	1.3	0.5	0.1
Between school 1 and school 2 (girls)	7.6**	6.6**	5.4*
Between total boys and total girls	2.4	0.0	8.1**
Between school 1 and school 2	7.7**	5.9*	3.2

[a]See Appendix.

Note: Chi square for one degree of freedom is 3.8 at the five per cent level, and 6.6 at the one per cent level. A single asterisk indicates significance at the five per cent level, a double asterisk at the one per cent level.

Among the various beyond data and general accuracy intercorrelations, the two involving school 1 and school 2 girls were significantly different at the one per cent level. Again pupils within a school, irrespective of sex, were more homogeneous than pupils in the two schools, especially in the case of girls.

The intercorrelations of caution and beyond data scores indicated significant differences between sexes rather than between schools. Most of the difference in the structure of this relationship probably arose from the differences between boys' and girls' scores in school 1, although the total relationship of boys was significantly different from that of girls. Girls in school 1 showed a tendency to be different from those in school 2.

[9] See Appendix.

Results of Table III may be summarized as follows:

1. In terms of the general accuracy and caution intercorrelations, school differences were significant, especially the difference between girls. This was also true in the case of the general accuracy and beyond data relationships.

2. In terms of caution and beyond data correlations, differences between the sexes were significant.

In the delimiting process some valuable data may have been arbitrarily excluded. However, it appears that the data which remain have useful inferential possibilities; that is, each of the three selected tests of ability to interpret data appeared to be a measure of something different and something useful.

FINDINGS

In fulfilling the purposes of this study, the ability to interpret data was studied in relation to 12 other measured attributes: chronological age, mental maturity, reading comprehension, mathematics knowledge and application, social studies knowledge and application, science knowledge and application, health knowledge, quality of school work, vocational interests, social competencies, personal adjustment, and socio-economic status. Of these, all but two were measured by standardized tests or rating scales; chronological age was taken from the records; a credit-point ratio, determined from past school marks, was used as an index of quality of school work.

In studying general accuracy in ability to interpret data, the school and sex groups were kept intact as well as combined in various combinations. In all, nine such combinations were considered in determining relationships of this ability to the other abilities. In studying the aspects of ability to interpret data known as "caution" and "going beyond data," only the total combined group was used. This uniform procedure made possible a consistency in the tabular presentation of the data.

Each table, then, shows the number of cases, the mean, and the variance for each variable, together with the correlation of that variable with the three abilities to interpret data. The number of cases varies from table to table, due to the factor of absence of some individuals on the various testing dates. However, it was observed that this variation had a negligible effect upon the mean and variance of the criterion measures. Accordingly, these particular statistics are not quoted in the tables, especially since they have already been presented and described in a previous section of the report. (See Table II, page 17.) Mention has already been made of the fact that the original statistics were computed from coded scores. These coded scores have been reconverted to original scores in the tables which follow.

Chronological Age

Table IV shows the means and variances in chronological age, and the correlation of chronological age with the three aspects of

ability to interpret data. In the table, "G.A." stands for general accuracy in interpreting data; "Caut." stands for caution in interpreting data; and "B.D." stands for a measured tendency to go beyond the data in interpreting data. The abbreviations are used also in succeeding tables.

TABLE IV. MEANS AND VARIANCES OF THE CHRONOLOGICAL AGES IN MONTHS, AND THE CORRELATION OF THESE AGES WITH SCORES ON THE INTERPRETATION OF DATA TEST

	Boys				Girls				Total					
	N	$\bar{X}$	s^2	r with G.A.	N	$\bar{X}$	s^2	r with G.A.	N	$\bar{X}$	s^2	r with G.A.	r with Caut.	r with B.D.
School 1	52	171	73	-.29	55	167	69	-.06	107	169	74	-.19		
School 2	56	170	90	-.29	66	167	43	-.02	122	168	67	-.21		
Total	108	170	82	-.29	121	167	55	-.03	229	169	70	-.20	-.07	.10

The boys in each school were somewhat older than the girls in that school, but there was no appreciable difference between schools in ages for the combined sex groups. The boys in school 2 were more variable in age than those in school 1, while the girls in school 1 were more variable than those in school 2. The lowest sex or school variance occurred for girls in school 2, which group also had the highest number of cases for which chronological age was available.

All correlation coefficients of general accuracy with chronological age were negative in character. All those for boys were of sufficient magnitude to indicate a correlation significantly different from zero. None of those for girls showed such indication.[10]

The number of cases for each variable in the study varies, but ranges from about 50 and more for each subgroup to about 300 for the total group.

For the combined sex groups within schools, as well as for the total group, the correlation between age and general accuracy was significantly different from zero.

Coefficients for the total group between age and either caution or beyond data were not high enough to indicate significant relation-

[10] Interpretation of the size of r is based upon the hypothesis that, if the population correlation were zero, a coefficient of correlation higher than the appropriate value entered below would not be obtained for any sample more than 5 times in 100.

N	r	N	r	N	r	N	r
50	.28	90	.21	160	.16	230	.13
55	.27	100	.20	170	.15	240	.13
60	.26	110	.19	180	.15	250	.12
65	.25	120	.18	190	.14	260	.12
70	.24	130	.17	200	.14	270	.12
75	.23	140	.17	210	.14	280	.12
80	.22	150	.16	220	.13	290	.12
						300	.11

The validity of procedure in applying the same interpretative conditions to combinations of sex and school groups probably rests in the degree to which the hypothesis is substantiated that the two schools are not radically different and not in radically different environmental settings. (At any rate, it is not the intent of the present investigators to infer any generalizations beyond the scope of the present samples.)

ships. The correlation with caution was negative, while that with beyond data was positive.

Empirical evidence often reveals a mild negative relationship between ability measures and age within a grade group. This same tendency was indicated for boys but not for girls in the present study.

Mental Maturity

Table V shows the means and variances of mental ages, and the correlation of mental ages with tested aspects of ability to interpret data. These mental ages are given for two types of mental maturity: non-language and language.

TABLE V. MEANS AND VARIANCES OF MENTAL AGES IN MONTHS AS MEASURED BY THE CALIFORNIA MENTAL MATURITY TEST, AND THE CORRELATION OF THESE MENTAL AGES WITH SCORES ON THE INTERPRETATION OF DATA TEST

	Boys				Girls				Total					
	N	$\bar{X}$	s^2	r with G.A.	N	$\bar{X}$	s^2	r with G.A.	N	$\bar{X}$	s^2	r with G.A.	r with Caut.	r with B.D.
NON-LANGUAGE														
School 1	53	168	549	.19	55	157	612	.35	108	163	615	.24		
School 2	57	176	627	.23	66	176	631	.40	123	176	629	.31		
Total	110	172	605	.23	121	168	718	.45	231	170	670	.32	-.07	-.17
LANGUAGE														
School 1	53	168	374	.49	55	172	229	.58	108	170	304	.53		
School 2	57	175	385	.66	66	178	311	.62	123	177	346	.64		
Total	110	172	392	.59	121	175	281	.62	231	174	336	.61	-.04	-.36

Non-language Ability. Mean non-language mental ages showed that the boys in school 1 ranked considerably higher than the girls in that school, while the boys in school 2 showed no superiority over the girls in school 2. Both boys and girls in school 2 showed higher average non-language mental ages than the respective groups in school 1. The girls in school 1 were lower on the average than any of the other three sex and school groups. Boys in school 2 and girls in school 1 and school 2 displayed little difference in variance, but the boys in school 1 were less variable than any of the other three groups.

Girls tended to show higher correlation than boys between general accuracy and non-language ability. All sex and school groups except school 1 boys, and all combination groups, including the total group, showed positive correlations between these two measured traits, which suggests the rejection of the hypothesis that the two traits are uncorrelated in the parent populations. The correlation for school 1 boys was almost high enough to follow this same general conclusion.

Correlation coefficients of the total group between non-language mental age and both caution and beyond data were negative in nature. That with caution was low enough to sustain the hypothesis that these traits are uncorrelated in a total population of similar groups, while that with beyond data was high enough to suggest the existence of some negative correlation in a parent population.

Empirical evidence suggests that there is positive correlation between mental maturity and other measurable school abilities. The correlations found here between non-language intelligence and general accuracy in interpreting data do not refute this evidence, although the boys exhibited less relationship than did the girls. A comparison of the measured relationship of general accuracy and language ability—a discussion of which follows in the next section—would seem to help substantiate a hypothesis which theorizes that non-language ability is less related than language ability to other measurable ability traits. Also, caution and tendency to go beyond data are apparently not the same types of traits as general accuracy in interpreting data.

Language Ability. The boys and girls in school 2 both showed some superiority over those in school 1 in language ability. School 2 girls showed the highest mean, followed in order by school 2 boys, school 1 girls, and school 1 boys. In each school, girls had higher average language mental ages than boys. There was a difference of seven months in the averages of the two schools when sexes were combined.

Variances for girls were somewhat lower than those for boys in school 2 and much lower than those for boys in school 1. Variances for both sex groups in school 2 were higher than those for the respective sex groups in school 1, but this difference was much more pronounced for girls than for boys. When the sexes were combined, there was not much difference in variance between schools, but when school groups were combined there was considerable difference in variance between sexes, with boys exhibiting greater variance than girls.

All correlation coefficients for general accuracy and language ability were positive and high enough to reject at the one per cent level the null hypothesis that no correlation exists between these two traits. The girls in school 1 exhibited about the same relationship between these two traits as the girls in school 2. However, the correlation coefficient for boys in school 2 was considerably higher than that for boys in school 1. When the sexes were combined, there were some differences in r's for the two schools, but when the schools were combined there was somewhat less difference in r's for the two sexes.

The total group correlation coefficient between caution and language ability suggested that there is little, if any, correlation between these two measured attributes for the parent population of which this combined group is representative. The r with beyond data strongly suggests a substantial amount of negative correlation for these two variables.

Many studies have shown positive correlation between language mental ability and other measurable abilities, especially those of a more or less academic nature. In this study, measured general accuracy in interpreting data seems likewise to exhibit this same positive relationship. It would appear that the relationship is even a little higher than that found in other studies between language intelligence and the more traditional tested school abilities.

Reading Comprehension

Table VI shows the means and variances of scores in tested aspects of reading comprehension, and the relationships of these scores to those in various aspects of the ability to interpret data. Scores on the reading comprehension test are vocabulary, speed of reading, and level of comprehension.

TABLE VI. MEANS AND VARIANCES OF SCORES ON THE READING COMPREHENSION TEST, AND THE CORRELATION OF THESE SCORES WITH SCORES ON THE INTERPRETATION OF DATA TEST

	Boys				Girls				Total					
	N	$\bar{X}$	s^2	r with G.A.	N	$\bar{X}$	s^2	r with G.A.	N	$\bar{X}$	s^2	r with G.A.	r with Caut.	r with B.D.
VOCABULARY														
School 1	53	34	90	.47	55	36	105	.48	108	35	98	.48		
School 2	59	40	90	.58	66	41	68	.53	125	41	79	.56		
Total	112	37	99	.55	121	39	92	.55	233	38	96	.55	.06	-.34
SPEED OF READING														
School 1	53	34	114	.60	55	40	115	.59	108	37	121	.60		
School 2	59	39	129	.64	66	42	75	.51	125	41	103	.60		
Total	112	37	127	.64	121	41	95	.55	233	39	115	.61	.05	-.35
LEVEL OF COMPREHENSION														
School 1	53	32	79	.60	55	35	81	.58	108	34	82	.59		
School 2	59	36	76	.68	66	39	72	.56	125	37	76	.63		
Total	112	34	81	.65	121	37	80	.59	233	36	82	.63	.05	-.38

Vocabulary. There was little difference in mean vocabulary scores of boys and girls in school 2; girls in school 1 had slightly higher averages than boys in school 1. Boys and girls in school 2 both surpassed their respective sex groups in school 1. When the sexes were combined, school 2 surpassed school 1 by an average of six points; when the schools were combined, the average vocabulary score of girls was slightly higher than that of boys.

Girls showed considerably less variance in vocabulary scores than did boys in both schools. There was apparently no difference between the variances of school 1 and school 2 boys, and only a slight difference between those of school 1 and school 2 girls. When sexes were combined, there was some difference in variances between schools.

The measured relationships of vocabulary and general accuracy in interpreting data were somewhat higher, for both sexes, in school 2 when compared with those in school 1. All coefficients for these two attributes were positive and substantial, ranging from the high .40's to the high .50's. Both sex groups of school 2 showed higher r's between these two variables than were exhibited by the respective sex groups in school 1. When the school groups were combined, the coefficient was about the same for boys as for girls.

The total group showed an r of .06 between vocabulary and caution. This was too low to refute the null hypothesis that no relationship exists between these two variables. The relationship between

vocabulary and beyond data was –.34, which is large enough to be significant at the one per cent level.

A comparison of vocabulary and interpretation of data relations with the correlation of speed of reading and level of comprehension with the same variables discloses rather consistent trends. The relationships of general accuracy and vocabulary are not quite as high as those for the other two variable combinations, but those for vocabulary and caution and for vocabulary and beyond data are substantially the same as those exhibited for the other respective combinations with other aspects of reading comprehension.

Speed of Reading. Both the boys' and girls' groups in school 2 averaged higher in speed of reading than did the respective sex groups in school 1. The girls' group both in school 1 and in school 2 surpassed the boys' group. When the sex groups were combined, there was a mean difference in favor of school 2 over school 1; when schools were combined, there was a mean difference in favor of all girls over all boys.

Boys in both schools and girls in school 1 had variances in reading speed which were fairly comparable. However, variance for school 2 girls was considerably lower than that for any of the other three groups. Combining the sexes resulted in a lower variance for school 2 than for school 1; combining schools resulted in a lower variance for all girls than for all boys.

Correlations between speed of reading and general accuracy for all groups were positive and substantial. Boys showed higher relationships between these two variables than did girls in either school, which likewise resulted in a higher exhibited relationship for all boys than for all girls. When the sexes were combined there was no difference between schools in the correlation of speed of reading and general accuracy.

The correlation for the total group between speed of reading and caution was too low to be significant; that between speed of reading and beyond data was negative and high enough to suggest a real negative relationship between these two measures.

The correlation of speed of reading with general accuracy was about the same as that of level of comprehension but slightly lower than that of vocabulary when correlated with the same variable. The statistics indicate about as much relationship existing between each of these three aspects of reading comprehension and general accuracy as was previously shown between general language ability and general accuracy, while there appeared to be more relationship between comprehension aspects and general accuracy than between general non-language ability and general accuracy. Speed of reading showed about the same relationship with caution and beyond data as did non-language, language, vocabulary, and level of comprehension abilities.

Level of Comprehension. School 2 boys and girls both demonstrated some superiority over their respective sex groups in school 1 in average level of comprehension scores. In both schools girls surpassed boys in this respect. This resulted in some difference in favor of school 2

when the sexes were combined, and in about the same difference in favor of the girls when the schools were combined.

There were no outstanding differences in variability for any sex group, school group, or combined group.

Boys showed higher relationships than did girls in the correlations between general accuracy and level of comprehension. In these correlations, school 2 boys had a higher r than school 1 boys, and the r for school 1 girls was slightly higher than that for school 2 girls. When the sexes were combined, the r for school 2 was .04 higher than that for school 1; when the schools were combined, the r for boys was .06 higher than that for girls. Neither of these differences appeared to be important in magnitude. Correlations between general accuracy and level of comprehension were all positive and significant.

Correlation coefficients for the total group between level of comprehension and caution were positive but insignificant. Between level of comprehension and beyond data, the correlation was negative and significant.

Mathematics Ability

Table VII shows the means and variances of various aspects of tested mathematics, and the correlation of these with general accuracy, caution, and the tendency to go beyond data in interpreting data. The studied aspects of mathematics ability consisted of a measure of skills; a measure of knowledge of facts, skills, and concepts; a measure of applications; and a measure of mathematical appreciation.

TABLE VII. MEANS AND VARIANCES OF SCORES ON THE COOPERATIVE MATHEMATICS TEST, AND THE CORRELATION OF THESE SCORES WITH SCORES ON THE INTERPRETATION OF DATA TEST

	Boys				Girls				Total					
	N	$\bar{X}$	s^2	r with G.A.	N	$\bar{X}$	s^2	r with G.A.	N	$\bar{X}$	s^2	r with G.A.	r with Caut.	r with B.D.
SKILLS														
School 1	53	45	61	.56	55	45	55	.42	108	45	58	.50		
School 2	57	43	55	.66	66	47	38	.45	123	45	49	.59		
Total	110	44	58	.59	121	46	47	.45	231	45	53	.54	-.02	-.27
FACTS, TERMS, AND CONCEPTS														
School 1	53	50	96	.44	55	51	104	.74	108	50	100	.59		
School 2	57	49	128	.70	66	52	94	.60	123	51	111	.66		
Total	110	50	113	.58	121	51	98	.64	231	51	106	.61	.04	-.37
APPLICATION														
School 1	53	46	106	.55	55	43	110	.53	108	45	110	.52		
School 2	57	44	142	.68	66	45	103	.51	123	45	122	.60		
Total	110	45	125	.60	121	44	108	.52	231	45	116	.55	.01	-.32
APPRECIATION														
School 1	53	47	118	.56	55	46	105	.65	108	46	111	.59		
School 2	57	43	153	.62	66	47	100	.38	123	45	128	.53		
Total	110	45	139	.56	121	47	102	.48	231	46	121	.53	.01	-.28

Mathematical Skills. In this tested ability the boys in each school showed mean superiority over the girls. This resulted in a 12-point difference in mean scores of all boys and all girls. When the sexes within schools were combined, however, the school means in round numbers were the same.

Variances in mathematical skills were about the same for the boys of school 2 and the girls of school 1. These two groups had slightly less variance than boys of school 1, but the girls of school 2 had considerably less variance than any of the other three sex and school groups. When the sexes were combined, variance for school 1 appeared to be somewhat higher than that for school 2. When the schools were combined, there was even more difference in variance for sexes than for schools, with the boys showing the higher variance.

Correlation of general accuracy in interpreting data with mathematical skills resulted in substantially higher obtained relationships for boys than for girls. In all group combinations the correlation of these two tested attributes was positive and highly significant. The school 2 combined sex group showed higher relationship between these abilities than the school 1 group. All boys showed considerably higher relationships than all girls.

The correlation for the total group of mathematical skills and caution in interpreting data was negative but insignificant in degree. In comparison to obtained correlations of caution with the other three mathematical aspects, there appeared to be little evidence of any difference at all, except that the other three mathematical variables showed positive coefficients. In fact, there appears to be strong evidence to support the theory that, in the parent population from which this sample was drawn, the correlation of caution with any of the four measures of mathematical skills is practically zero.

The correlation between mathematical skills and beyond data was negative and twice as large as the coefficient necessary to reject at the 5 per cent level the hypothesis that there is no correlation in the parent population. In comparison with the other measured mathematical variables, the correlation between skills and beyond data was about the same as that between mathematical appreciation and beyond data, and less than that between the other two measured mathematical aspects and beyond data. Thus there seems to be a substantial amount of negative correlation between the tendency to go beyond data and various measured aspects of mathematical ability in populations of which this sample is representative.

Mathematical Facts, Terms, and Concepts. Only minor differences were noted in the mean scores for the four sex and school groups in mathematical facts, terms, and concepts. This fact also operated to minimize mean differences between schools and between sexes. The fact that all four tested aspects of mathematics were graded on an equated score basis made possible some mean comparisons between aspects. Apparently both sexes and both schools, on the basis of group means, made somewhat higher scores in facts, terms, and concepts than in any of the other three variables.

There were some noticeable differences in group variances. School

1 boys and school 2 girls showed about the same amount of variance. School 2 girls were a little higher in variance, and school 2 boys had considerably more variance than either of the other three groups. A combination of sexes and of schools showed little difference in variance between schools or between all boys and all girls. On the whole, group variances for this particular tested aspect of mathematics ability were somewhat higher than those obtained for skills, but slightly lower than those obtained for the other three mathematics variables.

The correlation of facts, terms, and concepts with general accuracy in interpreting data revealed some interesting differences. For the four sex and school groups, correlation coefficients ranged from .44 for school 1 boys to .74 for school 1 girls, a difference of .30. School 2 boys showed much higher correlation than school 1 boys, and school 1 girls showed more correlation than school 2 girls. When sexes were combined by schools and within schools, these gross differences appeared to be somewhat smoothed out. On the basis of coefficients for all boys, the correlation between general accuracy and facts, terms, and concepts appeared to be about the same as between general accuracy and each of the other three mathematics variables. For all girls, however, the correlation between general accuracy and facts, terms, and concepts was higher than between general accuracy and any of the other three mathematics variables. Skills and appreciation showed the lowest correlation with general accuracy, while that for application was about midway between the two extremes. All group correlations between facts, terms, and concepts were positive and highly significant.

Relationship for the total group between caution and mathematical facts, terms, and concepts was positive but insignificant. Relationship for the total group between beyond data and facts, terms, and concepts was negative and significantly high.

Mathematical Application. Only minor differences in means for the four sex and school groups were noted for measured mathematical application. Likewise, the mean differences between schools and between all girls and all boys were of minor importance.

The highest amount of variability in this tested aspect was exhibited by the boys in school 2, where the variance was considerably larger than that for any of the other three groups. The difference in variances of school 1 boys, school 1 girls, and school 2 girls did not appear to be significantly large. When the sex groups were combined for the two schools and within the two schools, small differences in variance were noted between all boys and all girls, and between school 2 and school 1. In both cases the first-named group had the higher variance.

Correlation of general accuracy with mathematical applications was about the same for school 1 boys, school 2 boys, and school 2 girls, but was somewhat higher for school 1 girls. Combining the sexes within schools resulted in an obtained coefficient of correlation for school 2 which was slightly higher than that for school 1. Combining schools resulted in a higher coefficient of correlation for all boys than for all girls. All group coefficients of relationships between these two variables were positive and significant.

The measured relationship for the total group between mathematical applications and caution in interpreting data was positive but insignificantly low. The measured relationship for the total group between mathematical applications and beyond data was negative and highly significant.

Mathematical Appreciation. On the basis of mean scores, school 1 boys, school 2 boys, and school 2 girls were about the same in mathematical appreciation. School 2 girls were somewhat lower than any of these three groups. When schools were combined, all girls had some superiority in means over all boys; when sexes were combined, school 1 had a slightly higher mean than school 2.

Variance in mathematical appreciation was highest for school 2 boys; this same tendency had been noted both for mathematical applications and for mathematical facts, terms, and concepts. Combining sexes resulted in a slightly higher variance in school 1 than in school 2; combining schools resulted in still more difference in variance between all boys and all girls, with the boys having the greater variance.

Correlation coefficients for mathematical appreciation with general accuracy in interpreting data ranged from .38 for girls in school 2 to .65 for girls in school 1. The coefficient for boys in school 2 was just under that for girls in school 1; and that for boys in school 1 was a little below that for boys in school 2. There was only .08 difference in correlation coefficients for all boys and all girls, and only .06 difference for school 1 and school 2. In each of these instances the first-named group had the higher coefficient.

Correlation for the total group between mathematical appreciation and caution in interpreting data was positive but insignificant. Correlation for the total group between mathematical appreciation and going beyond data was negative and highly significant.

Empirical evidence has demonstrated that school abilities, as measured by standardized tests, show positive intercorrelations of about the same magnitude as those exhibited in these data between general accuracy and aspects of mathematics. In succeeding sections it will be demonstrated that general accuracy correlates to about the same degree with measured social studies ability, science ability, and health knowledge. Apparently, then, there is some variation in general accuracy in interpreting data which is associated with variation in the more highly delineated and defined school abilities.

The same line of reasoning, and looking ahead to succeeding sections of this report, would lead to the conclusion that a cautious attitude in interpreting data is not highly correlated with the measured school abilities listed above. A further conclusion would be that the tendency to go beyond data is substantially correlated with school subject abilities but in a negative direction. The tendency to go beyond the data, from this standpoint, is undesirable. All these conclusions, of course, are predicted upon the hypothesis that this sample is representative of a larger parent population. A broader interpretation and generalization must await more information to be obtained from more and better randomized samples.

Social Studies

Table VIII shows the means and variances of measured aspects of social studies abilities, and the correlation of these aspects with general accuracy, caution, and the tendency to go beyond the facts in interpreting data. The social studies tests included a measure of facts, skills, and application, a measure of knowledge of terms and concepts, and a measure of comprehension and interpretation.

TABLE VIII. MEANS AND VARIANCES OF SCORES ON THE COOPERATIVE SOCIAL STUDIES TEST, AND THE CORRELATION OF THESE SCORES WITH SCORES ON THE INTERPRETATION OF DATA TEST

	Boys				Girls				Total					
	N	$\bar{X}$	s^2	r with G.A.	N	$\bar{X}$	s^2	r with G.A.	N	$\bar{X}$	s^2	r with G.A.	r with Caut.	r with B.D.
FACTS, SKILLS, AND APPLICATION														
School 1	53	48	140	.52	55	45	163	.57	108	47	154	.52		
School 2	55	47	212	.74	66	49	111	.50	121	48	158	.64		
Total	108	47	177	.63	121	47	138	.55	229	47	157	.58	.06	-.37
TERMS AND CONCEPTS														
School 1	53	44	203	.56	55	44	120	.52	108	44	161	.54		
School 2	55	44	245	.64	66	48	197	.51	121	46	222	.59		
Total	108	44	224	.60	121	46	165	.53	229	45	194	.57	-.01	-.34
COMPREHENSION AND INTERPRETATION														
School 1	53	39	206	.61	55	40	143	.52	108	40	174	.57		
School 2	55	40	230	.72	66	44	176	.52	121	42	205	.63		
Total	108	40	219	.66	121	42	165	.53	229	41	192	.61	.06	-.39

Social Studies Facts, Skills, and Application. Mean differences in this tested aspect of social studies for the four sex and school groups were not pronounced. The greatest mean difference was that for girls in school 2 over girls in school 1, a difference of four equated score points. When sexes were combined, the difference was slight between school 1 and school 2. When the schools were combined, there was apparently no difference between all boys and all girls.

The boys in school 2 had considerably more variance than the girls in that school. These boys also had substantially higher variance than either the boys or the girls of school 1. Combining the sexes within schools resulted in an equalization of school variances, but combining schools showed a higher variance for all boys than for all girls.

The relationship between social studies facts, skills, and application was most pronounced in the case of school 2 boys, with a coefficient of .74. The lowest correlation coefficient appeared for school 2 girls, with an r of .50. School 2 showed somewhat higher correlation between these two variables than did school 1, while all boys showed more correlation than did all girls.

The correlation between caution and social studies facts, skills, and application was positive but insignificant. That between beyond data and the same variable was negative and significant.

Social Studies Terms and Concepts. Three of the groups—school 1 and school 2 boys and school 1 girls—had the same mean scores on social studies terms and concepts. School 2 girls were four score points higher on the average than any of the other three groups. This resulted in a higher mean for school 2 than for school 1, and a higher mean for all girls than for all boys.

Variances in social studies terms and concepts were higher for the sex groups in school 2 than for those in school 1. Also, boys in both schools had higher variances than girls. All boys had a higher variance than all girls, and the combined sexes in school 2 had a somewhat higher variance than the combined sexes in school 1.

Relationship between this social studies attribute and general accuracy in interpreting data was highest for school 2 boys, a continuation of a trend previously noted in other correlations involving general accuracy and other school subject abilities. Correlations of these two variables for the other groups showed only small differences. All girls showed lower measured relationships than all boys, and school 1 exhibited lower measured relationships than school 2.

For the total group the correlation of social studies terms and concepts with caution in interpreting data was negative but insignificant. For the same total group, the correlation between the social studies variable and beyond data was negative and highly significant.

Social Studies Comprehension and Interpretation. Mean comprehension and interpretation scores indicated some superiority in this tested aspect of school 2 girls over each of the other school and sex groups. When the sexes were combined within schools, school 2 had a mean which was two equated score points higher than the mean for school 1. When the schools were combined, all girls were higher than all boys in mean scores.

Variances for each of the groups of boys in comprehension and interpretation were higher than those for girls. Variances for each sex group in school 2 were somewhat higher than for the respective sex group in school 1. When the sexes were combined within schools, school 2 had the higher variance. All boys had a higher variance than all girls.

Correlations of comprehension and interpretation with general accuracy was higher for the boys' groups than for the girls' groups. The coefficient for boys in school 2 was higher than that for boys in school 1. This resulted in a higher coefficient for all boys than for all girls, and in a higher coefficient for the combined sexes in school 2 than for those in school 1. For the total group correlation of this social studies aspect with caution was positive but insignificant, while correlation with beyond data was negative and highly significant.

On the basis of mean scores, the boys did better on facts, skills, and application than on either of the other parts of the social studies test; they also did better on terms and concepts than on comprehension and interpretation. They were least variable on facts, skills, and application and showed about the same variances on terms and concepts as they did on comprehension and interpretation.

The girls had about the same means on facts, skills, and applica-

tion as they had on terms and concepts, but fell lower on comprehension and interpretation. They were somewhat more variable on terms and concepts and on comprehension and interpretation than on facts, skills, and application.

In all three aspects of social studies correlated with general accuracy in interpreting data the coefficients were higher for boys than for girls. Total group correlations were slightly higher between general accuracy and comprehension and interpretation than between general accuracy and either of the other two social studies tests.

The pattern of correlation coefficients involving relationships of the three interpretation of data tests and the three social studies tests followed most consistently the patterns observed with other school subject tests; that is, general accuracy showed substantial positive correlation with the subject tests, caution showed practically no correlation, and beyond data showed highly significant negative correlation.

Science

Table IX shows the means and variances of scores made on the cooperative science test and the correlation of these scores with scores made on general accuracy, caution, and the tendency to go beyond data in interpreting data. The science test consisted of a measure of facts, skills, and application, a measure of trends and concepts, and a measure of comprehension and interpretation. Equated scores were used in Table IX, which makes it possible to draw comparisons between the parts of the science test as well as between sex and school groups.

Science Facts, Skills, and Application. In this tested aspect of science the boys in each school made higher mean scores than did

TABLE IX. MEANS AND VARIANCES OF SCORES ON THE COOPERATIVE SCIENCE TEST, AND THE CORRELATION OF THESE SCORES WITH SCORES ON THE INTERPRETATION OF DATA TEST

	Boys				Girls				Total					
	N	$\bar{X}$	s^2	r with G.A.	N	$\bar{X}$	s^2	r with G.A.	N	$\bar{X}$	s^2	r with G.A.	r with Caut.	r with B.D.
FACTS, SKILLS, AND APPLICATION														
School 1	53	50	69	.55	55	46	82	.54	108	48	79	.51		
School 2	58	49	75	.60	64	46	71	.39	122	47	76	.43		
Total	111	50	72	.57	119	46	76	.42	230	48	77	.44	.01	-.24
TERMS AND CONCEPTS														
School 1	53	46	107	.59	55	44	85	.46	108	45	97	.52		
School 2	58	48	114	.64	64	46	96	.44	122	47	106	.50		
Total	111	47	112	.62	119	45	91	.45	230	46	102	.51	.07	-.32
COMPREHENSION AND INTERPRETATION														
School 1	53	40	167	.49	55	45	182	.53	108	43	179	.51		
School 2	58	43	209	.66	64	47	213	.33	122	45	214	.51		
Total	111	42	191	.59	119	46	200	.42	230	44	199	.51	.05	-.29

the girls. For boys the mean in school 1 was slightly higher than in school 2. For girls mean scores were the same in both schools. When the sexes were combined within schools, school 1 had a mean slightly higher than that of school 2. When the school groups were combined, all boys were four equated score points higher than all girls in mean.

The differences in variances for the sexes and school groups were not very pronounced. School 2 boys were slightly higher in variance than school 1 boys; school 1 girls were slightly higher than school 2 girls. Very little difference was noted in variances between schools or between all boys and all girls.

The correlation of facts, skills, and application with general accuracy was highest for the boys in school 2 and lowest for the girls in school 2. School 1 girls had a correlation coefficient somewhat higher than school 2 girls. When the sexes were combined within schools, the coefficient for school 1 exceeded that for school 2 by .08; when the schools were combined, the correlation for all boys exceeded that for all girls by .15.

The correlation for the total group of facts, skills, and application with caution was positive but insignificant. The correlation for the total group of facts, skills, and application with beyond data was –.24. This coefficient is approximately double the coefficient necessary to reject the hypothesis that there is no correlation of these aspects in the population from which this sample was drawn.

Science Terms and Concepts. The mean differences between sexes and school groups in this tested aspect of science were not very pronounced. In each school boys were slightly superior to girls on the basis of the means. Also the boys and girls in school 2 appeared to have some advantage over their respective sex groups in school 1. These differences resulted in a slightly higher mean for the combined sexes in school 2 than for those in school 1, and for all boys in comparison to all girls.

Variances for each of the boys' groups were higher than for either of the girls' groups. School 2 boys and girls showed higher variances than their respective sex groups in school 1. School 2 groups showed a higher variance than school 1 groups, and all boys showed a higher variance than all girls.

The measured relationships of science terms and concepts with general accuracy were considerably higher for each of the boys' groups than for either of the girls' groups. Not too much difference, however, was noted between schools for each of the sexes. The coefficient for all boys was .17 higher than that for all girls.

The relationships of terms and concepts with caution were positive but very low; with beyond data they were again negative and highly significant.

Science Comprehension and Interpretation. In contrast to the other two parts of the science test, the mean for girls in comprehension and interpretation in each school exceeded the mean for the boys' groups. School 2 sex groups were slightly superior to those of school 1 in mean scores, which resulted in a mean difference between schools of two equated score points when the sexes were combined within schools,

and a mean difference of four equated score points for all girls in comparison to all boys. Variances were higher for school 2 boys and girls than for either of the respective sex groups in school 1. When the sexes were combined, there was considerable difference in variance between school 1 and school 2, with the higher variance in school 2. However, the variance for all girls only slightly exceeded that for all boys.

There was a noticeable inconsistency in measures of relationship for sex and school groups between comprehension and interpretation and general accuracy. The lowest measured relationships appeared for girls in school 2, while the highest appeared for boys in school 2. Girls in school 1 had a higher coefficient than boys in school 1. When the sexes were combined within schools, these differences tended to cancel out, leaving the same coefficient for school 1 as for school 2. When the schools were combined, all boys had a correlation coefficient .17 higher than all girls.

When comprehension and interpretation was correlated with caution for the total group, it gave a positive coefficient of insignificant magnitude. Again, comprehension and interpretation correlated with beyond data and gave a negative but highly significant coefficient.

In general the boys were higher in mean scores on facts, skills, and application than on either of the other two tested aspects of science. They were also somewhat higher on terms and concepts than on comprehension and interpretation. On the other hand, the girls were quite consistent on all aspects of tested science ability, as indicated by mean scores.

Variances for both groups were lowest for facts, skills, and application, and highest for comprehension and interpretation.

In general, boys showed higher measured relationships of science abilities with general accuracy in interpreting data than did girls. There was not much difference for either sex group in measured relationships of any of the three science test parts, one with another, but the lowest correlation for the total group appeared for facts, skills, and application with general accuracy. All of the correlations with general accuracy and various aspects of science ability appeared to be slightly lower than comparable correlations with tested aspects of other subject-matter measures.

Correlations of the parts of the science test with caution in interpreting data followed very much the same general pattern as those noted in previous discussions of other subject-matter tests. The same patterns were also noted in correlations of parts of the science test with beyond data.

Health Knowledge

Table X shows the means and variances in tested health knowledge, and the correlation of health knowledge with general accuracy in interpreting data, with caution in interpreting data, and with the tendency to go beyond the data in making interpretations.

In mean scores for health knowledge, the girls' group exceeded the boys' group in each school. However, differences in mean scores

TABLE X. MEANS AND VARIANCES OF SCORES ON THE HEALTH KNOWLEDGE TEST, AND THE CORRELATION OF THESE SCORES WITH SCORES ON THE INTERPRETATION OF DATA TEST

	Boys				Girls									
	N	$\bar{X}$	σ^2	r with G.A.	N	$\bar{X}$	σ^2	r with G.A.	N	$\bar{X}$	σ^2	r with G.A.	r with Caut.	r with B.D.
School 1	51	34	58	.54	52	37	57	.60	103	35	60	.57		
School 2	59	36	63	.61	66	39	48	.54	125	38	56	.60		
Total	110	35	63	.60	118	38	53	.57	228	37	60	.60	-.00	-.32

were not too pronounced, since these means had an over-all range of only five score points. Each of the school 2 groups averaged about two score points higher than the school 1 groups.

The girls in school 2 had the lowest variance, while the boys in school 1 had the highest. The difference in variances between schools for combined sex groups was less than the difference between all boys and all girls; all boys were more variable than all girls.

Correlations between health knowledge and general accuracy were all positive and of about the same magnitude as those found between other measures of school abilities and general accuracy. School 1 girls and school 2 boys exhibited the highest relationships for these two variables. The coefficient for the combined sexes of school 2 was slightly higher than that for school 1, while all boys showed slightly higher relationships than all girls.

Correlation for the total group between health knowledge and caution was practically non-existent. That for health knowledge and beyond data was negative and highly significant.

All of the findings which are concerned with relationships of health knowledge and aspects of ability to interpret data follow the same general pattern as those which have previously been listed for other tested school abilities with the same interpretative abilities.

Credit Point Ratio

Table XI shows the means and variances in credit point ratios for the school and sex groups, and the correlation of these ratios with general accuracy, caution, and the tendency to go beyond the data in interpretations.

Mean credit point ratios for school 1 boys, school 1 girls, and school 2 girls were the same; school 2 boys were somewhat lower

TABLE XI. MEANS AND VARIANCES OF CREDIT POINT RATIOS, AND THE CORRELATION OF THESE RATIOS WITH SCORES ON THE INTERPRETATION OF DATA TEST

	Boys				Girls				Total					
	N	$\bar{X}$	σ^2	r with G.A.	N	$\bar{X}$	σ^2	r with G.A.	N	$\bar{X}$	σ^2	r with G.A.	r with Caut.	r with B.D.
School 1	74	13	16	.43	71	13	22	.64	145	13	19	.54		
School 2	75	10	12	.49	78	13	19	.48	153	11	18	.50		
Total	149	11	16	.38	149	13	21	.53*	298	12	19	.47	-.02	-.31

on the average. All boys were consequently a little lower than all girls, and the school 2 combined sex group was a little lower than the same group in school 1.

The girls in both schools were more variable than the boys in credit point ratios. School 1 girls were slightly more variable than school 2 girls, and school 1 boys were somewhat more variable than school 2 boys. All boys were more variable than all girls. For the combined sex group there was only a slight difference in variances between schools.

Sex and school group correlations between credit point ratios and general accuracy in interpreting data were lowest for school 1 boys and highest for school 1 girls. School 2 boys and school 2 girls showed the same coefficient of correlation for these two variables. When the sexes within schools were combined, school 1 showed a correlation which was slightly higher than that for school 2. When the schools were combined, all boys showed lower relationship between these two variables than did all girls.

Correlations between credit point ratios and caution in interpreting data were negative but insignificant. Correlation between credit point ratios and beyond data were negative and highly significant.

In general, quality of school work as measured by the credit point ratio exhibited about the same patterns of relationship with the three aspects of interpretative ability as did tested school abilities in English, mathematics, social studies, and science areas, although the correlations with general accuracy were slightly lower than those obtained for most of the other measured attributes.

Vocational Interests

Table XII shows the means and variances for the school and sex groups on various aspects of the Kuder Preference Record, and the correlation of these scores with general accuracy, caution, and the tendency to go beyond the data in interpreting data. Raw scores on the Kuder measure, which were the bases of computations in this table, are not directly comparable for the two sexes, since there is a different set of forms for each sex. This creates some difficulty in comparing the means and variances of the two sexes, but does not invalidate comparisons of the same sex groups in different schools, and has no invalidating effect on any comparisons of correlation coefficients.

In order to solve partially the problem of intersex comparisons, another table was constructed. Table XIII shows the percentiles corresponding to the mean scores for the four school and sex groups on aspects of the Kuder measure of vocational preferences. Since both Table XII and XIII are very extensive, and since many of the correlation coefficients are of insufficient magnitude to do other than sustain the hypothesis that there is little if any correlation between these particular variables in a population of which this is a sample, the procedure here will be to summarize the tables rather than to present a more detailed analysis.

The boys of school 1 had higher means than did those in school

TABLE XII. MEANS AND VARIANCES OF SCORES ON THE KUDER PREFERENCE RECORD, AND THE CORRELATION OF THESE SCORES WITH SCORES ON THE INTERPRETATION OF DATA TEST

	Boys				Girls				Total					
	N	$\bar{X}$	s^2	r with G.A.	N	$\bar{X}$	s^2	r with G.A.	N	$\bar{X}$	s^2	r with G.A.	r with Caut.	r with S.D.
MECHANICAL														
School 1	75	80	297	.08	68	46	157	-.27	143	64	516	-.06		
School 2	64	82	301	-.27	80	42	276	-.01	144	59	684	-.20		
Total	139	81	300	-.09	148	44	225	-.14	287	62	606	-.15	-.06	.03
COMPUTATIONAL														
School 1	75	32	49	-.07	68	29	62	.10	143	31	58	.01		
School 2	64	31	95	.06	80	31	130	.05	144	31	114	.05		
Total	139	32	70	.00	148	30	100	.10	287	31	86	.04	-.11	.04
SCIENTIFIC														
School 1	75	64	150	.17	68	48	92	.05	143	56	183	.08		
School 2	64	66	195	.14	80	46	247	.09	144	55	322	.01		
Total	139	65	172	.16	148	47	177	.05	287	55	253	.03	-.06	-.03
PERSUASIVE														
School 1	75	67	105	.17	68	61	164	-.09	143	64	142	.03		
School 2	64	69	194	-.26	80	67	215	-.31	144	68	175	-.29		
Total	139	68	118	-.04	148	64	200	-.15	287	66	162	-.11	-.09	-.02
ARTISTIC														
School 1	75	57	178	.09	68	60	179	-.10	143	59	180	.00		
School 2	64	56	132	-.25	80	56	278	-.21	144	56	213	-.21		
Total	139	57	162	-.07	148	58	464	-.19	287	57	198	-.13	-.02	.04
LITERARY														
School 1	75	42	115	.07	68	49	130	-.07	143	45	134	.01		
School 2	64	43	162	.22	80	52	219	.01	144	48	214	.14		
Total	139	43	137	.16	148	51	181	.01	287	47	177	.11	.02	-.10
MUSICAL														
School 1	75	20	76	-.16	68	29	90	.08	143	24	105	-.01		
School 2	64	18	63	-.05	80	30	103	.08	144	24	119	.10		
Total	139	19	74	-.11	148	29	98	.10	287	24	112	.05	-.12	-.02
SOCIAL SERVICE														
School 1	75	67	173	-.21	68	74	260	.16	143	70	225	.00		
School 2	64	64	106	-.24	80	77	297	-.06	144	71	252	-.05		
Total	139	66	144	-.23	148	75	282	.06	287	71	239	-.03	.01	-.05
CLERICAL														
School 1	75	54	81	-.08	68	64	128	.10	143	59	127	.03		
School 2	64	55	127	-.03	80	72	286	-.10	144	64	207	.02		
Total	139	55	102	-.05	148	68	228	.05	287	62	215	.06	-.09	.09

2 in the tested aspects of computational, artistic, musical, and social service preferences. The boys in school 2 had higher means than did those in school 1 in the tested aspects of mechanical, scientific, persuasive, literary, and clerical preferences. The largest difference between boys' means in the two schools was one of 14 centile points in social service preferences. Most of the differences were only one or two score points, corresponding to about four to seven or eight centile points.

The girls in school 1 had higher means than did those in school 2 in the tested aspects of mechanical, scientific, and artistic preferences. The girls in school 2 had higher means than the girls in school 1 in the tested aspects of computational, persuasive, literary, musical, social service, and clerical preferences. The greatest difference in girls' means was exhibited for persuasive and clerical preferences, with a difference of 17 percentile points each. Differences be-

tween girls' means were more pronounced than differences between boys' means.

In school 1, girls had higher mean centiles than boys in computational, scientific, literary, and musical preferences. Boys had higher mean centiles than girls in mechanical, persuasive, artistic, social service, and clerical preferences.

In school 2, girls had higher mean centiles than boys in computational, literary, musical, and clerical preferences. Boys had higher mean centiles than girls in mechanical, scientific, persuasive, artistic, and social service preferences. Thus, there was some consistency of patterns of mean differences in the two schools, since six of the nine aspects showed mean centile differences in favor of the same group in both schools.

On the basis of centiles corresponding to the means, all boys showed the highest preferences in artistic interests, followed in order by social service, musical, clerical, persuasive, mechanical, scientific, computational, and literary interests. In only the last three of these aspects did all boys have a mean centile of less than 50. Average artistic preferences were very high.

TABLE XIII. PERCENTILE EQUIVALENTS OF MEAN SCORES OF BOYS AND GIRLS IN EACH SCHOOL ON THE VARIOUS PARTS OF THE KUDER PREFERENCE RECORD

	Boys		Girls	
	X	Percentile	X	Percentile
MECHANICAL				
School 1	60	50	46	44
School 2	62	54	42	32
Total	61	52	44	38
COMPUTATIONAL				
School 1	32	40	29	52
School 2	31	36	31	60
Total	32	40	30	57
SCIENTIFIC				
School 1	64	40	48	43
School 2	66	45	46	37
Total	65	42	47	40
PERSUASIVE				
School 1	67	51	61	38
School 2	69	59	67	55
Total	68	56	64	46
ARTISTIC				
School 1	57	75	60	71
School 2	56	73	56	63
Total	57	75	58	67
LITERARY				
School 1	42	36	49	53
School 2	43	40	52	60
Total	43	40	51	57
MUSICAL				
School 1	20	62	29	70
School 2	18	55	30	73
Total	19	59	29	70
SOCIAL SERVICE				
School 1	67	70	74	36
School 2	64	56	77	45
Total	66	62	75	40
CLERICAL				
School 1	54	53	64	52
School 2	55	56	72	69
Total	55	56	68	61

On the basis of centiles corresponding to the means, all girls showed the highest preferences in musical interests, followed in order by artistic, clerical, literary, computational, persuasive, social service, scientific, and mechanical interests. In only the last four of these aspects did all girls have a mean centile of less than 50. Girls' preferences for musical interests were very high.

In variances the boys of school 2 exceeded the boys of school 1 in all tested aspects except artistic, musical, and social service. Variances for the girls in school 2 exceeded those for the girls in school 1 in every tested aspect. It was shown previously that both the boys and the girls in school 2 had some advantage over the respective sex groups in school 1 in non-language and language ability as well as in many of the tested school subject abilities. It is interesting to speculate that there may be some connection between all of these facts—an hypothesis which might be worthy of more investigation in the future.

In the correlation of the variables which comprise the different aspects of tested preferences with the variables in aspects of ability to interpret data, only a few correlaions were obtained the magnitude of which would support the hypothesis that there was a correlation in the universe from which these samples were obtained.

Only one correlation of such size occurred with caution in interpreting data; that was the total group r between caution and musical preferences. Correlation of caution with computational preferences came close to being significantly different from zero at the five per cent level.

In light of all the evidence listed above, it must be concluded that there is little if any correlation between abilities to interpret data and vocational preferences.

Social Competency

Table XIV shows the means and variances of scores on the social competency test and the correlation of these scores with general accuracy in interpreting data, caution in interpreting data, and the tendency to go beyond data in interpretations. The test of social competency has four aspects; namely, the competency to solve health problems, the competency to solve problems pertaining to personal economics, the competency to solve problems pertaining to family and community relationships, and the competency to solve social-civic problems.

Competency in Solving Health Problems. School 2 boys and school 2 girls had considerably higher mean scores in health than did their respective sex groups in school 1. When the sexes were combined, therefore, the mean for school 2 exceeded that for school 1. When the schools were combined, the mean for all girls exceeded the mean for all boys. In this tested aspect school 2 girls had the highest variance and school 1 boys the lowest variance. Variances were about the same for school 2 boys and school 1 girls. The combined sexes in school 2 had considerably more variance than the combined sexes in school 1. All girls had considerably more variance than all boys when the schools were combined.

TABLE XIV. MEANS AND VARIANCES OF SCORES ON THE SOCIAL COMPETENCY TEST, AND THE CORRELATION OF THESE SCORES WITH SCORES ON THE INTERPRETATION OF DATA TEST

	Boys				Girls				Total					
	N	$\bar{X}$	s^2	r with G.A.	N	$\bar{X}$	s^2	r with G.A.	N	$\bar{X}$	s^2	r with G.A.	r with Caut.	r with B.D.
HEALTH														
School 1	50	64	136	.37	55	69	187	.15	105	66	170	.26		
School 2	58	70	188	.47	63	74	279	.28	121	72	240	.38		
Total	108	67	173	.45	118	72	242	.27	226	69	215	.36	-.07	-.16
PERSONAL ECONOMICS														
School 1	50	45	82	.57	55	50	60	.42	105	48	77	.51		
School 2	58	50	74	.63	63	53	81	.53	121	51	80	.60		
Total	108	48	82	.61	118	52	73	.50	226	50	81	.58	.09	-.35
FAMILY AND COMMUNITY RELATIONSHIP														
School 1	50	39	59	.26	55	43	54	.46	105	41	60	.37		
School 2	58	42	46	.41	63	44	47	.49	121	43	48	.47		
Total	108	40	54	.36	118	43	50	.47	226	42	54	.43	-.05	-.23
SOCIAL-CIVIC PROBLEMS														
School 1	50	68	313	.28	55	75	158	.34	105	72	244	.31		
School 2	58	70	201	.50	63	73	220	.40	121	72	214	.46		
Total	108	69	253	.39	118	74	192	.34	226	72	228	.38	-.08	-.19

The highest relationships between ability to solve health problems and general accuracy in interpreting data were exhibited for school 2 boys, followed in order by school 1 boys, school 2 girls, and school 1 girls. Of these four group correlation coefficients, that for school 1 boys was the only one that did not represent a coefficient statistically different from zero. All boys had a coefficient of .45, compared to a coefficient of .27 for all girls. The coefficient for the total group on these two variables was .36, which was somewhat less than that observed between general accuracy and other tested school subject abilities.

The correlation of competency to solve health problems with caution in interpreting data was negative, but insignificant. The correlation of competency to solve health problems with beyond data was negative and significant, but not highly significant.

Competency in Solving Problems Pertaining to Personal Economics. In mean scores for personal economics, the boys and girls in school 2 were somewhat superior to their respective sex groups in school 1. Consequently, when the sexes were combined within schools, the mean for school 2 exceeded that for school 1. When the schools were combined, all girls exceeded all boys.

School 1 girls had the lowest variance while school 1 boys and school 2 girls had the highest variance. However, differences in variances were not very pronounced, and for combined groups these differences tended further to be averaged out.

Correlation coefficients between competency in solving problems of personal economics and general accuracy in interpreting data were all positive and substantial. In general, the coefficients for boys were higher than those for girls. The coefficient for the combined sexes in school 2 was higher than that in school 1.

Correlation of personal economics with caution was positive but not significant. Correlation of personal economics with beyond data was negative and highly significant.

Competency in Solving Problems Pertaining to Family and Community Relationships. The mean scores on family and community relationships were about the same for three of the sex and school groups; school 1 boys averaged somewhat lower than any of the other three groups. School 2 boys and girls together had a mean slightly higher than had all pupils in school 1. All girls averaged higher than all boys.

Differences in variance were not pronounced, but the sex groups in school 1 slightly exceeded those in school 2.

The correlation of family and community relationships with general accuracy in interpreting data was highest for school 2 girls and lowest for school 1 boys. The coefficient for school 1 boys was not high enough to reject the hypothesis that there is no correlation in the parent population from which this sample was drawn. The school 2 combined sex groups showed higher relationships than the combined sex groups in school 1. All girls showed higher relationships than all boys.

The correlation of family and community relationships with caution in interpreting data was negative but insignificant. The correlation of family and community relationships with beyond data was negative and significant.

Competency in Solving Social-Civic Problems. School 2 boys had a mean score in social-civic problems slightly superior to that for school 1 boys. School 1 girls averaged higher than school 2 girls. When the sexes were combined within schools, there was apparently no difference between the mean of school 1 and the mean of school 2. However, all girls averaged higher than all boys when schools were combined.

Variances for school 2 boys and school 2 girls were about the same; school 1 boys had the highest variance, and school 1 girls the lowest variance of the four groups. This resulted in an interesting situation wherein the highest variance was associated with the lowest group mean, and the lowest variance was associated with the highest group mean. When the sexes were combined within schools, differences in school variances were not pronounced. However, variances for all boys greatly exceeded those for all girls.

Correlations between competency in solving social-civic problems and general accuracy in interpreting data were all positive. The coefficient for school 1 boys was barely significant, but the coefficients for the other three groups considerably exceeded this particular statistic. School 2 sex groups showed higher correlation than the respective sex groups in school 1. All boys showed slightly higher relationships than all girls.

The correlation of competency in solving social-civic problems with caution was negative and insignificant; while with beyond data it was negative and significant.

In general, the obtained correlations on aspects of the social-civic test with general accuracy in interpreting data were all positive but not quite as pronounced as those found for other tested aspects of school abilities with this same variable. With general accuracy all boys showed the highest relationship for the aspect of personal economics and the lowest for family and community relationships, while all girls showed the highest relationship for personal economics and the lowest for health. Boys exceeded girls in observed relationships between general accuracy and health, personal economics, and social-civic problems, while girls exceeded boys in relationships exhibited with family and community relationships.

In line with a consistency previously observed for all of the variables in this study, there was apparently little, if any, correlation between aspects of social competency and caution in interpreting data. Also in line with previous observations, the correlations of aspects of social competency with beyond data were all negative and significant. This was most pronounced in the case of personal economics and least pronounced in the case of health.

Personal Adjustment

Table XV shows the means and variances of scores made by the

TABLE XV. MEANS AND VARIANCES OF SCORES ON THE BELL ADJUSTMENT INVENTORY, AND THE CORRELATION OF THESE SCORES WITH SCORES ON THE INTERPRETATION OF DATA TEST

	Boys				Girls				Total					
	N	$\bar{X}$	s^2	r with G.A.	N	$\bar{X}$	s^2	r with G.A.	N	$\bar{X}$	s^2	r with G.A.	r with Caut.	r with B.D.
HOME ADJUSTMENT														
School 1	77	7	28	.16	74	8	51	.22	151	8	39	.18		
School 2	75	6	16	.26	79	6	23	.08	154	6	20	.17		
Total	152	7	23	.21	153	7	37	.20	305	7	30	.20	.00	-.09
HEALTH ADJUSTMENT														
School 1	77	9	19	.09	74	10	26	.24	151	9	23	.02		
School 2	75	9	17	.14	79	8	26	.19	154	8	22	.18		
Total	152	9	18	.11	153	9	27	.26	305	9	23	.18	.02	-.05
SOCIAL ADJUSTMENT														
School 1	77	17	41	-.05	74	17	52	.14	151	17	46	.05		
School 2	75	17	44	.32	79	15	56	.12	154	16	53	.24		
Total	152	17	42	.15	153	16	57	.23	305	16	50	.17	-.04	-.02
EMOTIONAL ADJUSTMENT														
School 1	77	11	35	-.03	74	17	46	.12	151	14	49	.02		
School 2	75	11	43	.21	79	13	53	.03	154	12	49	.08		
Total	152	11	39	.10	153	15	52	.13	305	13	50	.07	-.01	-.02

various groups on the Bell Adjustment Inventory and the correlation of these scores with general accuracy in interpreting data, caution in interpreting data, and the tendency to go beyond data in interpreting data. The aspects of personal adjustment included home adjustment, health adjustment, social adjustment, and emotional adjustment. In interpreting means on the parts of this test, a high score is indicative of less satisfactory adjustment, and a low score is indicative of more satisfactory adjustment.

Home Adjustment. Both the boys and the girls in school 2 appeared to be better adjusted, on the average, than the respective sex groups in school 1; differences were slight, however, and mean scores of all four groups fell in an area which is listed in the test manual as average.

Variances were more pronounced for the groups in school 1 than for those in school 2, and variances for girls were somewhat higher than those for boys, especially in school 1. Of the nine possible correlations of home adjustment with general accuracy in interpreting data, six were of sufficient magnitude to suggest that correlations in the parent population were different from zero. The groups for which significant correlations between these two aspects were obtained were school 2 boys, all boys, all girls, school 1 total, school 2 total, and the total group. All of these correlations were positive, but none of them was high enough to be of much value for predictive purposes.

Correlation between home adjustment and caution was apparently zero; that between home adjustment and beyond data was negative but insignificant.

Health Adjustment. On the basis of mean scores the boys in school 1 and school 2 appeared to be about the same in health adjustment. Girls in school 2 appeared to be a little better adjusted than girls in school 1. The means for both boys and girls seemed to be low average on the basis of the test norm.

Variances for girls somewhat exceeded those for boys, while variances between schools produced negligible differences.

The correlations between health adjustment and general accuracy in interpreting data were significant for four of the nine primary and combined groups: school 1 girls, all girls, school 2 total, and total. Apparently, then, for these samples these two aspects were more highly correlated for girls than for boys. All correlation coefficients between health adjustment and general accuracy were positive but none of them was high enough to have much predictive value.

The correlation between health adjustment and caution in interpreting data was positive but practically zero. The correlation between health adjustment and beyond data was negative but likewise insignificant.

Social Adjustment. Differences in social adjustment means for the four school and sex groups were practically non-existent, with only the girls in school 2 ranging somewhat lower in mean, which would be higher in adjustment, than those in school 1. Mean scores for all four groups fell at about the middle of the average range according

to norms for the test. Variances for girls somewhat exceeded those for boys. Differences in variances between schools were slight.

Only school 2 boys, all girls, school 2 total, and total groups showed correlations between social adjustment and general accuracy in interpreting data which would lead to a conclusion that there was some correlation in the population from which the samples had been drawn. With one exception all correlation coefficients were positive. Rather striking differences in correlation coefficients appeared for school 1 boys, with –.05, compared to school 2 boys, with .32.

Correlations between social adjustment and caution and between social adjustment and beyond data were both negative but insignificant.

Emotional Adjustment. The boys in school 1 had the same mean in emotional adjustment as those in school 2. This mean fell at the lowest part of what is average according to the test norms. The girls in school 2 were better adjusted on the average than those in school 1.

Girls had slightly higher variances than boys, with both boys and girls in school 2 somewhat exceeding variances for their respective sex groups in school 1.

All but one of the correlations of emotional adjustment and general accuracy in interpreting data were positive but none of these coefficients were significant.

The correlations of emotional adjustment with caution and of emotional adjustment with beyond data were negative but practically zero.

On the basis of the number of significant correlations obtained, it appeared that, for these samples, home adjustment correlated more highly with general accuracy than did any of the other adjustment areas. Emotional adjustment showed the lowest correlation of the four adjustment variables. For these samples there was apparently little correlation between any of the adjustment aspects and either caution in interpreting data or the tendency to go beyond data in interpretations.

Socio-Economic Status

Table XVI shows the means and variances of scores on the American Home Scale and the correlation of these scores with scores on general accuracy in interpreting data, caution in interpreting data, and the tendency to go beyond data in interpretations. The American Home Scale is a self-rating of environmental conditions of which part scores, cultural environment, aesthetic environment, and economic environment, were considered in the present study.

Cultural Environment. On the basis of mean scores there appeared to be practically no differences in the cultural environmental background of any of the four sex and school groups.

Variances for school 2 were somewhat less than those for school 1 for the respective sex groups.

Girls showed higher correlations than boys between cultural environment and general accuracy in interpreting data. All correlations for these two aspects were positive, but none of the coefficients was large enough to be of much value for prediction. Significant cor-

TABLE XVI. MEANS AND VARIANCES OF SCORES ON THE AMERICAN HOME SCALE, AND THE CORRELATION OF THESE SCORES WITH SCORES ON THE INTERPRETATION OF DATA TEST

	Boys				Girls				Total					
	N	$\bar{X}$	σ^2	r with G.A.	N	$\bar{X}$	σ^2	r with G.A.	N	$\bar{X}$	σ^2	r with G.A.	r with Caut.	r with B.D.
CULTURAL														
School 1	77	11	16	.14	72	11	15	.26	149	11	16	.13		
School 2	75	10	13	.04	80	11	10	.24	155	11	11	.16		
Total	152	10	15	.09	152	11	12	.23	304	11	14	.16	-.07	-.09
AESTHETIC														
School 1	77	6	3	.02	72	6	3	.23	149	6	3	.12		
School 2	75	6	4	-.08	80	6	3	.23	155	6	3	.06		
Total	152	6	4	-.08	152	6	3	.25	304	6	3	.10	-.01	-.10
ECONOMIC														
School 1	77	8	4	.23	72	8	3	.36	149	8	3	.29		
School 2	75	8	3	.04	80	8	4	.24	155	8	4	.15		
Total	152	8	3	.14	152	8	3	.28	304	8	3	.22	-.04	-.20

relations were obtained for girls in school 1, girls in school 2, all girls, school 2 total, and the total of the two schools.

Correlation of the rating of cultural environment with caution in interpreting data was negative but insignificant. Correlation of the rating of cultural environment with a tendency to go beyond data was likewise negative and insignificant.

Aesthetic and Economic Environment. Mean scores for all groups in aesthetic environment and also in economic environment were the same. There were only slight differences in variances for all the groups in these two tested aspects.

The relationships of ratings of aesthetic environment with general accuracy in interpreting data were higher for girls than for boys. Only in the case of all girls was a correlation obtained which was significantly different from zero. The correlations for school 2 boys and all boys were negative but insignificant; all other coefficients for these two variables were positive. Correlation of aesthetic environment with caution was negative and practically zero; that of aesthetic environment and beyond data was negative but insignificant.

The correlations between economic environment and general accuracy in interpreting data were higher for girls than for boys, but the differences were not quite as noticeable as in the case of general accuracy and aesthetic environment. School 1 boys, school 1 girls, school 2 girls, all girls, school 1 total, and school 2 total gave correlation coefficients which were significantly different from zero but none was high enough to be of much value for predictive purposes.

Correlation between economic environment and caution was negative and insignificant. Correlation between economic environment and beyond data was likewise negative, but was of sufficient magnitude to suggest that there was some correlation in the parent population.

In general the relationships of each of these tested aspects of environment with general accuracy suggest that for some of the samples

there was some relationship existing in the parent population. For these samples there appeared to be very little relationship between environmental aspects and the tendency to go beyond data in interpretations, and practically no correlation between environmental aspects and caution in interpreting data.

SUMMARY

Reliabilities of the various parts of the interpretation of data scores were substantial and were about the same as those presented by Tyler[11] and his associates.

TABLE XVII. ANALYSIS OF VARIANCE OF GENERAL ACCURACY SCORES[a]

Source	d.f.	Sum of Squares	Mean Square	F
Between sexes	1	1955.1	1955.1	5.64*
Between schools	1	2767.8	2767.8	7.99**
Sex and school interaction	1	76.9	76.9	
Experimental error	301	81162.0	269.6	
Total	304	85961.8		

[a]For the procedure used in computing this table, see: Fei, Tsao, "Tests of Statistical Hypotheses in the Case of Unequal or Disproportionate Numbers of Observations in the Subclass," Psychometrika 7:195-212, September, 1942.

Tests of significance of two parts of the interpretation of data scores, general accuracy and crude error scores, are presented in Tables XVII and XVIII. No tests were computed for the other scores because inspection showed the various group differences to be too small to be significant. In the case of general accuracy, differences between schools were significant at the one per cent level, while those between sexes were significant at the five per cent level. Crude error scores, which are roughly the inverse of general accuracy scores, indicated differences between schools and between sexes that were both significant at the one per cent level. In neither crude error nor general accuracy scores was there evidence of an interaction effect. In other words, girls scored significantly higher than boys, and school 2 pupils

TABLE XVIII. ANALYSIS OF VARIANCE OF CRUDE ERROR SCORES[a]

Source	d.f.	Sum of Squares	Mean Square	F
Between sexes	1	693.0	693.0	9.8**
Between schools	1	1230.1	1230.1	17.3**
Sex and school interaction	1	0.0[b]	0.0[b]	
Experimental error	301	21362.0	71.0	
Total	304	23285.1		

[a]For the procedure used in computing this table, see: Fei, Tsao, "Tests of Statistical Hypotheses in the Case of Unequal or Disproportionate Numbers of Observations in the Subclass," Psychometrika 7:195-212, September, 1942.

[b]The interaction was too small to show up with the number of decimal digits carried.

[11] Smith, Tyler, and the Evaluation Staff, *op. cit.*

scored significantly higher than school 1 pupils in terms of these two tested performances.

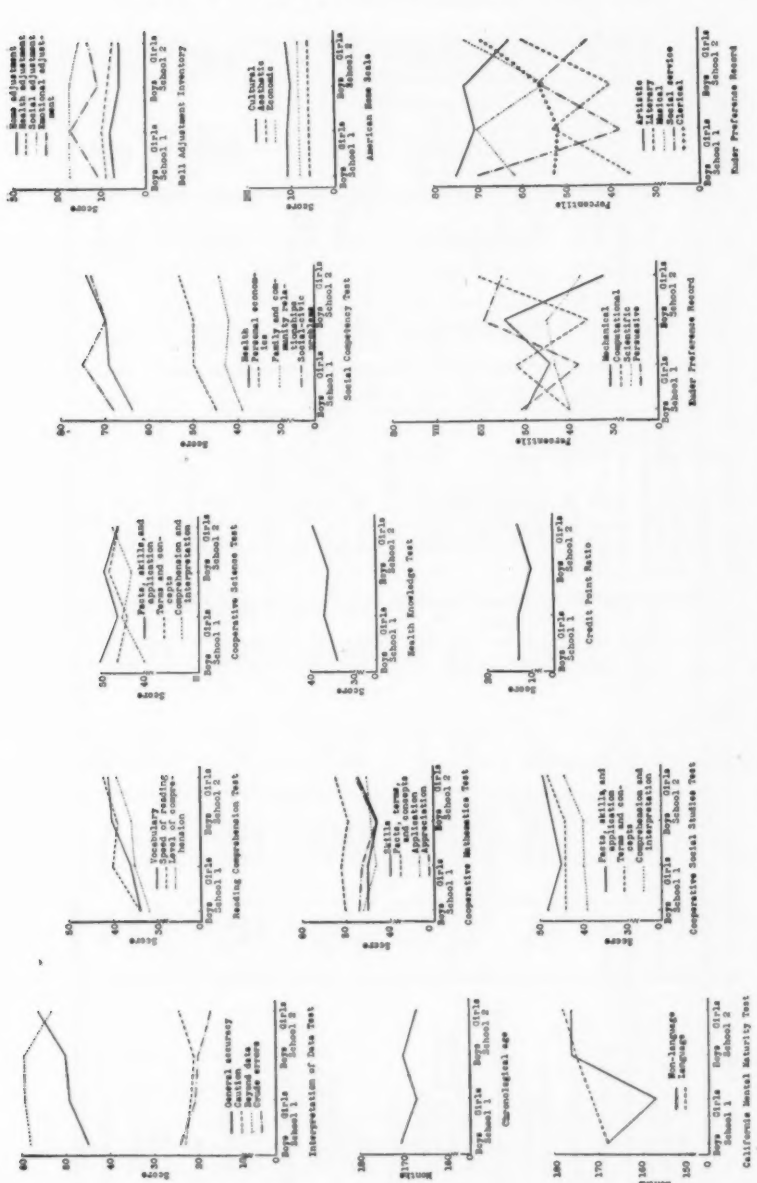
Intercorrelations between general accuracy, beyond data, and caution scores have been presented in Table II and chi-square tests of significance of these have been given in Table III. The following differences in relationships were significant at the one per cent level: between school 1 and school 2 girls on general accuracy scores, between school 1 and school 2 girls on beyond data, between boys and girls in school 1 on caution, and between the totals of boys and girls, irrespective of school, on caution scores. If a difference in correlation magnitude indicates a difference in structuring of ability to interpret data, then these may be said to represent such differences and it becomes necessary to investigate the nature of this structure both by a study of mean performance of the various groups in relation to one another and by a study of the correlations of scores within each of the groups in terms of the criterion of general accuracy. Detailed data with reference to these questions have been presented in Tables IV to XVI.

A summary of the mean scores is shown in Chart I. Mean performance of various groups on the different measures may be compared graphically with the mean performance indicated for the criterion measure at the top of the chart.

Throughout the findings illustrated in Tables IV to XVI, the relationships of the various test scores to three of the criterion test scores (general accuracy, caution, and beyond data) have been presented in detail. Only those concerned with general accuracy, however, will be summarized. The general accuracy correlations are summarized in Table XIX, with those showing significant association being indicated. The combined measures were made up of the scores on subtests comprising a given test; the science test, for example, was composed of subtest scores on facts, on terms, and on interpretation. Each of these scores was correlated with the criterion general accuracy. In Table XX the correlations of the total scores on each measure were combined in terms of their inverse hyperbolic tangent transformed values into a chi-square value.

Age did not have a significant association with general accuracy. Each of the measures of academic achievement showed a combined association with general accuracy for both boys and girls that was significant well beyond the one per cent level. Whatever structure is involved in general accuracy ability to interpret data seems to be heavily weighted with factors of intelligence and achievement both in terms of standard tests and of classroom work.

Interests as measured by the Kuder Preference Record exhibited no significant association with general accuracy when the nine interest score correlations were combined. Inspection of the correlation Table XIX indicates why this is true. The social competence test uniformly showed a significant association. Whether this was true because the test measures some social traits that exhibit such association or because the measure is merely one which correlates highly with academic performance is conjectural. The Bell Adjustment Inventory exhibited significant association in the case of school 2 boys. The index of socio-economic status (American Home Scale) in the case of girls



MEANS OF BOYS AND GIRLS IN EACH SCHOOL ON EACH OF THE MEASURES

TABLE XIX. SUMMARY OF CORRELATIONS BETWEEN GENERAL ACCURACY AND THE VARIOUS MEASURED ASPECTS OF PUPIL PERFORMANCE

Measured Aspect Correlated With General Accuracy	School 1		School 2	
	Boys	Girls	Boys	Girls
CHRONOLOGICAL AGE	-.29*	-.06	-.29*	-.02
MENTAL MATURITY				
Non-language	.19	.35*	.23	.40**
Language	.49**	.58**	.66**	.62**
READING COMPREHENSION				
Vocabulary	.47**	.48**	.58**	.53**
Speed of reading	.60**	.59**	.64**	.51**
Level of comprehension	.60**	.58**	.68**	.56**
MATHEMATICS				
Skills	.56**	.42**	.66**	.45**
Facts	.44**	.74**	.70**	.60**
Application	.55**	.53**	.68**	.51**
Appreciation	.56**	.65**	.62**	.36**
SOCIAL STUDIES				
Facts	.52**	.57**	.74**	.50**
Terms	.56**	.52**	.64**	.51**
Interpretation	.61**	.52**	.72**	.52**
SCIENCE				
Facts	.55**	.54**	.60**	.39**
Terms	.59**	.46**	.64**	.44**
Interpretation	.49**	.53**	.66**	.33**
HEALTH KNOWLEDGE	.54**	.60**	.61**	.54**

Measured Aspect Correlated With General Accuracy	School 1		School 2	
	Boys	Girls	Boys	Girls
CREDIT POINT RATIO	.43**	.64**	.48**	.48**
VOCATIONAL INTERESTS				
Mechanical	.08	-.27*	-.27*	.01
Computational	-.07	.10	.06	.05
Scientific	.17	.05	.14	.09
Persuasive	.17	-.09	-.26*	-.31*
Artistic	.09	-.10	-.25	-.21
Literary	.07	-.07	.22	.01
Musical	-.16	.08	-.05	.08
Social service	-.21	.16	-.24	-.06
Clerical	-.08	.10	-.03	-.10
SOCIAL COMPETENCY				
Health	.37*	.15	.47**	.28*
Personal economics	.57**	.42**	.63**	.53**
Family and community relationships	.26	.46**	.41**	.49**
Social-civic	.28	.34**	.50**	.40**
PERSONAL ADJUSTMENT				
Home	.16	.22	.26*	.08
Health	.09	.24	.14	.19
Social	-.05	.14	.32**	.12
Emotional	-.03	.12	.21	.03
SOCIO-ECONOMIC STATUS				
Cultural	.14	.26*	.04	.24*
Aesthetic	.02	.23	-.08	.25*
Economic	.23	.36**	.04	.24*

TABLE XX. CHI-SQUARE VALUES[a] OF THE CORRELATIONS BETWEEN GENERAL ACCURACY SCORES AND VARIOUS COMBINED MEASURES

	School 1		School 2	
	Boys	Girls	Boys	Girls
Chronological age	4.37	1.88	4.73	0.25
Mental maturity	16.21**	29.77**	36.91**	44.49**
Reading comprehension	61.05**	60.93**	95.27**	67.11**
Mathematics	70.31**	106.77**	140.06**	75.10**
Social studies	61.75**	56.34**	119.71**	59.88**
Science	56.45**	49.94**	92.61**	31.11**
Health knowledge	17.52**	23.54**	28.14**	22.99**
Credit point ratio	15.02**	39.09**	19.69**	20.51**
Vocational interests	11.61	10.07	21.32	13.79
Social competency	34.01**	30.99**	71.57**	53.87**
Personal adjustment	2.78	10.25*	17.72**	4.47
Socio-economic status	5.56	18.47**	0.69	13.45**

[a]For computational details, see Appendix.

Note: Chi square for one degree of freedom is 3.8 at the five per cent level, and 6.6 at the one per cent level. A single asterisk indicates significance at the five per cent level, a double asterisk at the one per cent level.

exhibited an association which was significant at the one per cent level for both schools.

Another question concerned with correlations is the one dealing with sex differences, that is, did a significant difference in correlation with general accuracy exist between sexes for the various scores? Data relative to this question are given in Table XXI. Only 2 out of 24 chi-square values presented are significant at the five per cent level, and none are significant at the one per cent level. In other words, there is in reality no sex differentiation in terms of the correlation of measured abilities with general accuracy so far as the data of the present investigation are concerned.

A reasonable conclusion from the data presented in this investigation is that ability to interpret data, especially as indicated by the general accuracy scores, seems to be closely associated with those

TABLE XXI. CHI-SQUARE VALUES[a] OF THE DIFFERENCES BETWEEN THE CORRELATIONS OF GIRLS AND BOYS FOR GENERAL ACCURACY SCORES VERSUS THE VARIOUS COMBINED MEASURES

	School 1[b]	School 2[b]
Chronological age	1.43	2.23
Mental maturity	1.17	1.18
Reading comprehension	0.03	2.43
Mathematics	7.24	8.78
Social studies	6.59	8.80
Science	0.91	10.50*
Health knowledge	0.19	0.33
Credit point ratio	3.09	0.00
Vocational interests	17.98*	6.51
Social competency	3.80	2.81
Personal adjustment	3.15	3.26
Socio-economic status	2.92	4.00

[a]For computational details, see Appendix.

[b]Boys minus girls.

Note: See explanation on Table XX.

factors which also make up typical group measures of intelligence and achievement. The adjustment and interest scores as a whole indicate a distinctly lower order of association.

Differences between schools 1 and 2 in terms of the magnitude of association were not significant for measures of achievement, socio-economic status, and intelligence. These are presented in Table XXII.

TABLE XXII. CHI-SQUARE VALUES[a] OF THE DIFFERENCES BETWEEN SCHOOL CORRELATIONS FOR GENERAL ACCURACY SCORES VERSUS VARIOUS COMBINED MEASURES

	School 1 Minus School 2		School 1 Minus School 2
Chronological age	0.02	Vocational interests	19.99**
Mental maturity	3.33	Social competency	17.33*
Reading comprehension	1.70	Personal adjustment	12.36*
Mathematics	4.16	Socio-economic status	2.54
Social studies	6.78		
Science	0.94		
Health knowledge	0.11		
Credit point ratio	0.22		

[a]For computational details, see Appendix.

Note: See explanation on Table XI

The measure of social competency had an association in school 1 which was significantly greater than that in school 2, but the Kuder Preference Record and Bell Adjustment Inventory correlations reached only the five per cent level.

It is the conviction of the authors that more exhaustive analysis of the present data, such as a factor analysis, would be less fruitful than a series of experiments designed to isolate the significant variables in classroom and other situations.

APPENDIX I

CHI-SQUARE TEST FOR DIFFERENCES BETWEEN PAIRS OF CORRELATIONS

The sampling distribution of r was first attacked by Pearson and Filon,[1] in 1898, who showed that $\sigma_r = \frac{1-\rho^2}{\sqrt{N}}$, where ρ is the correlation in the population. In practice this formula was unfortunately modified to a standard error, $SE_r = \frac{1-r^2}{\sqrt{N}}$, and applied without due regard to the limitation of a large N and restriction of ρ to the neighborhood of zero. How large N should be is generally not specified. David[2] showed that even with a sample of 400 the distribution curves for $\rho > 0.6$ showed very wide divergence from normal distribution.

Definite progress toward the solution of the distribution of r when N is small was made by "Student"[3] in 1906 who, on the basis of practical sampling studies, found the distribution of r for $\rho = 0$, and any N, to be

$$f(r|N,\rho=0) = \frac{\Gamma(\frac{N-1}{2})}{\sqrt{\pi}\,\Gamma(\frac{N-2}{2})}(1-r^2)^{\frac{N-4}{2}}.$$

Soper[4] in 1913 gave an approximate formula for the more general case, and R. A. Fisher in 1915 gave the general distribution law for ρ = any value.

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[1] Pearson, K., and Filon, L. N. G., "On the Probable Errors of Frequency Constants," Philosophical Transactions of the Royal Society (London) 191A:229-311. 1898.

[2] David, F. N., Tables of the Correlation Coefficient, Biometrika Office, University of London, 1938.

[3] "Student," "On the Probable Error of a Correlation Coefficient," Biometrika 6:302-310, 1906.

[4] Soper, H. E., "On the Probable Error of the Correlation Coefficient to a Second Approximation," Biometrika 9: 91-115, 1913.

Fisher[5] in 1915 used a geometric proof to show that the distribution function of r, for any ρ was

$$f(r|N,\rho)\frac{(1-\rho^2)^{\frac{N-1}{2}}}{\pi(N-3)!}(1-r^2)^{\frac{N-4}{2}}\frac{d^{N-2}}{d(r\rho)^{N-2}}\left[\frac{\cos^{-1}(-\rho r)}{\sqrt{1-\rho^2r^2}}\right]$$

This integral is not easy to tabulate. A distinct improvement was achieved by Fisher[6] in 1921, when he showed that by a suitable transformation of r and ρ the distribution curves of r could be transformed approximately into normal curves.

$$\text{Let } z' = \tfrac{1}{2}\log\frac{1+r}{1-r} = \tanh^{-1}r$$
$$= \tfrac{1}{2}\log\frac{1+\rho}{1-\rho} = \tanh^{-1}\rho.$$

Fisher then showed that moments of $f(z'|N,\zeta)$ were:

$$\text{mean } (z') = \zeta + \frac{\rho}{2(N-1)}\left[1 + \frac{1+\rho^2}{8(N-1)} + \ldots\right]$$

$$\text{variance } (z') = \frac{1}{N-1}\left[1 + \frac{4+\rho^2}{2(N-1)} + \frac{176-21\rho^2-21\rho^4}{48(N-1)^2} + \ldots\right]$$

$$\beta_1(z') = \frac{\rho^2}{(N-1)^3}(\rho^2 - \frac{9}{16})^2 + \ldots$$

$$\beta_1(z') = 3 + \frac{32-3\rho^4}{16(N-1)} + \frac{128-112\rho^2-57\rho^4-9\rho^6}{32(N-1)^2} + \ldots$$

In practice, however, it is customary to assume that z' is normally distributed about r with variance equal to $\frac{1}{N-3}$. The proof of this follows immediately.

$$(\sigma_{z'})^2 = \frac{1}{N-1}\left[1 + \frac{4-\rho^2}{2(N-1)} + \frac{176-21\rho^2-21\rho^4}{48(N-1)^2} + \ldots\right]$$

Omitting the remaining terms and considering only the first three terms, this becomes

$$(\sigma_{z'})^2 = \frac{1}{N-1}\left[1 + \frac{4}{2(N-1)} + \frac{176}{48(N-1)^2}\right] = \frac{3N^2+8}{3(N-1)^3}$$

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[5]Fisher, R. A., "The Frequency Distribution of the Values of the Correlation Coefficient in Samples from an Indefinitely Large Population," Biometrika 10:507-21, 1915. (Formula shows the probability distribution of r for any N when ρ is any real value.)

[6]Fisher, R. A., "On the Probable Error of a Coefficient of Correlation Deduced from a Small Sample," Metron 1:1-30, 1921.

Inverting gives $\frac{1}{(\sigma_{z'})^2} = \frac{3(N-1)^3}{3N^2+8} = N-3 + \frac{N+21}{3N^2+8}$, whence $(\sigma_{z'})^2 \cong \frac{1}{N-3}$.

Instead of calculating areas of the distribution curves of r, the problem is put in the form of a normal curve. The transformation is simple and David[7] has shown it to be accurate over the whole range of values of ρ and r.[8]

The z' transformation also provides a convenient and accurate means of testing the significance of correlations. It can be generalized so as to test a whole group of correlations simultaneously. Since the standard error of z', for practical purposes, is $\frac{1}{\sqrt{N-3}}$, the quantity $z'\sqrt{N-3}$ is distributed approximately normally with unit standard deviation in samples from a population with zero association, hence[9] chi square equals $\sum_{1}^{k} (z_1 1\sqrt{N_1-3})^2$ with k degrees of freedom where k is the number of samples.

This test is superior to that involving the mean z'

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[7] David, F. N., op. cit.

[6] It can be readily shown that the error committed by neglecting $\frac{N+21}{3N^2+8}$ is

N	$\frac{N+21}{3N^2+8}$
5	0.31
10	0.10
15	0.05
25	0.02

The error committed by neglecting ρ is v, where

$$v = \frac{\rho^2(8N-1+7\rho^2)}{16(N-1)^3} = \frac{8(N-1)\rho^2-7\rho^4}{16(N-1)^3}, \text{ or}$$

N	(v|ρ = .5)	(v|ρ = .9)
5	.010	.030
10	.002	.006
15	.009	.003

[9] This follows from the fact that $\frac{\Sigma(x-\bar{x})^2}{\sigma^2}$ equals chi-square. If $\sigma^2 = 1$, chi square equals the sum of the squares

value, which assumes that the samples are all from the same population and that the variations in r are due solely to random errors.

It may happen that the variations in association are indicative of real test differences and that in general there is a correlation within each measuring device which is sometimes positive and sometimes negative, so that the mean is nearly zero. The z' and chi-square test enables one to test whether association exists after making allowances for differences between tests.

Obviously it is possible to extend the chi-square test to testing differences between pairs of correlations. When testing a given pair of correlations for significance, the t-ratio is $t = \frac{z'_1 - z'_2}{\sqrt{\frac{1}{N_1-3} + \frac{1}{N_2-3}}}$, and thus chi-square for pairs of differences is $\sum_1^k (z'_1 - z'_2)^2 \frac{(N_1-3)(N_2-3)}{N_1+N_2-6}$, with degrees of freedom equal to number of pairs being tested or k.

It should be added that the mean departure of the average z' from the true z' is not zero, but is subject to a slight bias, or $\overline{z'} - \zeta_1 = \frac{\rho}{2N-1}\left[1 + \frac{1+\rho^2}{8(N-1)} + \cdots\right]$. In precise work with z' this requires that a small correction be made to the obtained z', which is approximately $\frac{\rho}{2(N-1)}$, and which must be subtracted arithmetically from z'. For the most practical work Fisher has shown that the correction is unnecessary. The use of transformed correlations, $\tanh^{-1} r$, for testing significance of heterogeneity among them is only valid when the coefficients are independent. Thus, the z' test is not valid for testing homogeneity of a group of intercorrelations, but it is valid for testing differences between pairs of independent correlations from similar samples as in the case of school 1 versus school 2, or boy versus girl relationships.

Bulletins in the Field of Education, Indiana University

The Bulletin of the School of Education, Indiana University, was first published in 1924 and has appeared regularly since that time. Research studies of interest to educators, proceedings of conferences held, and bibliographies of educational materials have been the principal fields touched upon in these bulletins. A complete list of the bulletins may be obtained from the School of Education upon request. The studies included in the present volume and in the two volumes immediately preceding it in date are listed below. Unless otherwise noted, these may be obtained for 50 cents each from the Indiana University Bookstore, Bloomington, Indiana.

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The Language and Mental Development of Children. By Ruth G. Strickland. Vol. XXIII, No. 2, 1947. 31 p.

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